APPENDIX H

SUPPORTING INFORMATION FOR INDOOR AIR PATHWAY EVALUATION

This Appendix presents supporting information developed for the indoor air pathway evaluation. As discussed in Section 4.3.6 of the Baseline Risk Assessment Report, evaluation of the indoor air pathway at the site is complex, since workplace indoor air monitoring, shallow soil and soil gas, deep soil and soil gas, and groundwater data all required consideration.

It is important to consider all potential contributing sources of contamination when evaluating indoor air exposures, including both surface and subsurface sources. Surface sources include indoor chemical use and chemicals in outdoor (ambient) air. Subsurface sources include contamination that is present in soil, soil gas or groundwater. For the purposes of this risk assessment, the contribution from subsurface sources was considered most relevant since that is where residual contamination from the former rubber plant would primarily occur.

This Appendix presents supporting information for the correlation analysis that was used to determine what data set (indoor air versus subsurface data) is most relevant for evaluating potential risks from vapor migration into indoor air. In addition, supporting information regarding chemical sources in indoor and outdoor air is presented.

H.1 Correlation Analysis

A correlation analysis was completed to evaluate whether indoor air data or modeling of subsurface soil/soil gas data should be used to estimate indoor air exposure associated with former rubber plant contamination. The analysis compared indoor air concentrations with shallow subsurface concentrations for each Exposure Area of Potential Concern (EAPC) where indoor air sampling was conducted. A positive correlation between shallow subsurface concentrations and indoor air concentrations (i.e., higher subsurface concentrations paired with higher indoor air concentrations) would indicate that subsurface sources were a contributor to the indoor air concentrations and suggest that direct use of the measured indoor air data was the preferred method of evaluating risk for the pathway. Alternatively, a poor or nonexistent correlation would suggest that vapor intrusion from the subsurface is not the primary factor controlling the measured indoor air concentrations in this case. Under this outcome, vapor transport modeling of the subsurface data would be the preferred approach for evaluating the vapor intrusion pathway for the site.

The correlation analysis consisted of both graphical and nonparametric statistical evaluations. The graphical evaluation consisted of plotting average indoor air concentrations versus average soil concentrations for both benzene and PCE, the primary chemicals of interest for the indoor air pathway. Plots of concentration rank for benzene and PCE in shallow soil and indoor air were additionally prepared. The plots are presented in figures H-1 through H-4 and the corresponding data points for the charts are identified in Table H-1. The EAPC number for each data point is labeled on the charts. EAPCs where NAPL is present are also identified on the plots.

The graphical analyses show wide scatter in the rank graphs and clustering of data along the y-axis in the concentration graphs, indicating there is no correlation between shallow subsurface impacts and indoor air concentrations. Similar results are indicated on charts plotting mean EAPC groundwater concentrations versus indoor air concentrations (figures H-5 through H-8; Table H-2).

Further support for the above conclusion is provided through a non-parametric statistical analysis. Correlation coefficients can be useful metrics to assist in the graphical evaluation of the association between variables. For parametric analysis, these tests measure the linear relationship between variables with a correlation coefficient (r2) indicating the fit of a line drawn through the data points. For non-parametric data, the equivalent Spearman's Rank correlation coefficient is used to measure the degree of association. Values can range from -1 (negative correlation) to +1 (positive correlation) with values close to 0 suggesting no correlation. For example, positive correlation coefficients indicate that an increase in shallow soil gas concentration has a corresponding increase in indoor air concentration. The benzene and PCE correlation coefficients are presented on Tables H-1 (shallow soil correlation) and H-2 (groundwater correlation). Mirroring the conclusions from the graphical analysis, correlation coefficients for site subsurface and measured indoor data were low (-0.2 to +0.2), indicating no correlation.

The data were also subjected to a statistical test to determine if the observed association was statistically significant. In this case, the non-parametric Spearman's rho correlation test was performed, evaluating the probability that the observed association between the variables could have arisen by chance alone. A statistically significant correlation is indicated when the probability of incorrectly identifying that an association exists is less than 5% ($p<0.05$). Calculated P-values are presented on Tables H-1 (shallow soil correlation) and H-2 (groundwater correlation). P-values for the site data ranged from 0.47 to 0.76, meaning that it is highly likely that the observed association is the result of chance.

Based on the correlation analysis results described above, modeling of subsurface data collected at the site was judged to be the preferred method by which to evaluate risks from the vapor intrusion pathway. Modeling of subsurface data has an additional benefit over the direct use of indoor air data in that this approach can be used for almost all of the EAPCs. This is not possible with direct use of the measured indoor air data, since these data are only available for 13 of the 37 EAPCs. While the lack of a positive correlation between subsurface and indoor air data supports the preferential use of the modeling approach over measured indoor air data, it does not rule out the possibility that subsurface sources have contributed to indoor air concentrations. Measured indoor air concentrations are influenced by many factors, including building-specific ventilation and air-exchange rates that could potentially mask soil vapor intrusion contributions.

H.2 Evaluation of Indoor and Background Sources to Measured Indoor Air Concentrations

Exposure estimates based on measured and modeled indoor air concentrations are presented in the Baseline Risk Assessment. Although measured indoor air concentrations may appear to be the most direct source for indoor air exposures, there are limitations to using these data to evaluate exposures resulting from subsurface impacts. As was discussed in Section H.1, there was no correlation found between indoor air data and subsurface data. Therefore, additional sources other than subsurface sources are likely contributing to measured indoor air concentrations.

Chemical of Potential Concern (COPC) concentrations from indoor air monitoring data can be considered from other background sources given sufficient evidence of background indoor air sources for the chemical. Lines of evidence to identify such sources include the following:

a) **COPC use identified during the pre-sampling building inventory**
The building descriptions and chemical inventories from the workplace air monitoring program (URS, 2001) were reviewed to identify indoor sources of COPCs. The presence or use of gasoline and petroleum distillates was identified in six buildings and routine loading and unloading of diesel trucks was noted for two buildings. In these cases, it was inferred that indoor sources for benzene, toluene, ethylbenzene, xylene, cyclohexane, and styrene were present. A summary of chemicals sources (chemical products or activities that may be a source of chemicals in indoor air) identified during the pre-sampling inventory for each EAPC is presented in Table H-3. COPCs identified during the pre-sampling inventory for each EAPC are summarized in Table H-4.

b) **Measured indoor air concentrations were less than or similar to typical indoor air background values**
Typical background indoor air concentrations for site COPCs were identified through a literature review. Results from several studies were considered and a representative background indoor air concentration was selected. These background concentrations are summarized in Table H-5. No statistical analysis was conducted to determine the Typical Literature Value listed in Table H-5. A

value was selected based on the range of indoor air background data provided for a particular compound. For many chemicals, the reported background concentrations are lower in the more recent studies. This is an indication that background concentrations are decreasing with time. All of the studies reviewed report a range of measured background concentrations and many of the measured concentrations from the Site are within the range of these background values. Consequently, the majority of measured concentrations from the Del Amo Workplace Air Monitoring Program may be entirely a result of background sources even though they are not considered to be background values for this evaluation.

c) **Indoor air chemical concentrations were less than or similar to outdoor air concentrations**

Box plots of site-wide outdoor air concentrations and workplace air monitoring data for each EAPC were prepared to compare indoor and outdoor air concentrations. The box plots for each COPC are provided in Figures H-9 through H-30. If the median indoor air concentration at an EAPC was less than or similar to the median outdoor air concentration, then the measured indoor air concentration can be considered similar to the outdoor air concentration and potentially present in indoor air due to the contribution of outdoor air.

TABLE H-1
SHALLOW SOIL CORRELATION CHART DATA SHEET

BENZENE					
EAPC	**Mean Concentration, shallow soil**	**Mean Concentration, indoor air**	**shallow soil rank**	**indoor air rank**	**Notes:**
23	3.0200	25.90	1	1	
16	2.3900	4.57	2	13	
5	0.4140	11.90	3	6	
9	0.3340	5.19	4	11	
17	0.1760	7.44	5	9	
28	0.0092	5.03	6	12	
18	0.0036	13.70	7	5	
21	0.0031	8.63	8	8	
22	0.0008	21.10	9	2	
2	0.0000	9.73	11.5	7	shallow soil all ND
4	0.0000	14.40	11.5	4	shallow soil all ND
19	0.0000	17.40	11.5	3	shallow soil all ND
25	0.0000	6.97	11.5	10	shallow soil all ND
background	0.0000	5.77			

R^2	-0.212
P	0.469

PCE					
EAPC	**Mean Concentration, shallow soil**	**Mean Concentration, indoor air**	**shallow soil rank**	**indoor air rank**	**Notes:**
16	2.44	3.76	1	10	
5	0.0139	7.51	2	5	
19	0.0085	6.13	3.5	7	
28	0.0085	32.8	3.5	1	
22	0.0014	8.84	5	4	
21	0.0007	6.62	6	6	
18	0.0003	10.2	7	3	
17	0.0001	3.98	8.5	9	
25	0.0001	2.63	8.5	12	
2	0	4.69	11	8	shallow soil all ND
4	0	18.7	11	2	shallow soil all ND
9	0	3.26	11	11	shallow soil all ND
background	0	3.44			
23	NO PCE DATA FOR EAPC 23				

R^2	0.194
P	0.527

TABLE H-2
GROUNDWATER CORRELATION CHART DATA SHEET

BENZENE				
EAPC	**Mean Concentration, GW**	**Mean Concentration, Indoor air**	**GW rank**	**Indoor air rank**
2	0	9.73	13	7
4	0.89	14.40	12	4
5	260,000	11.90	5	6
9	670,000	5.19	2	11
16	340,000	4.57	3	13
17	100	7.44	11	9
18	1,000	13.70	10	5
19	10,000	17.40	9	3
21	42,000	8.63	8	8
22	290,000	21.10	4	2
23	820,000	25.90	1	1
25	59,000	6.97	7	10
28	140,000	5.03	6	12
background	0	5.77		

R^2 -0.0879
P 0.764

PCE				
EAPC	**Mean Concentration, GW**	**Mean Concentration, Indoor air**	**GW rank**	**Indoor air rank**
28	0	32.8	8	1
4	0	18.7	8	2
18	0	10.2	8	3
22	0	8.84	8	4
5	0	7.51	8	5
21	0	6.62	8	6
19	4.8	6.13	3	7
2	0	4.69	8	8
17	0	3.98	8	9
16	2,100	3.76	1	10
9	0	3.26	8	11
25	32	2.63	2	12
background	0	3.44		
23		none		

R^2 -0.551
P not valid due to numerous non-detects

Table H-3
Chemicals Sources Identified During Pre-Indoor Air Sampling Inventory

	EAPC												
CHEMICAL	2[A]	4	5	9	16	17	18	19	21	22	23	25	28
Petroleum Distillates [1]	X						X				X	X	X
Gasoline [2]										X			
Diesel truck Loading/Unloading		X										X	
Benzene					X								
Toluene		X		X	X	X	X	X	X	X	X	X	X
Xylenes	X	X		X	X	X	X	X	X	X	X	X	X
1,1,1 TCA	X				X		X	X	X	X			X
PCE					X				X	X			X
MEK	X	X					X	X					
Methylene Chloride		X	X							X			X
Cyclohexane										X			
Styrene		X											
Acetone		X											
Methanol		X											
Propane		X			X						X	X	
Freon 11													X
Ethylene Glue											X		
Gear lube and Grease											X		
Automatic transmission fluid											X		
C9-C12 Alkylbenzenes					X				X				
Naphthenes					X				X				
Saturated Naphthenes		X											
Napthol Spirits					X								
Mineral Spirits					X								X
Mineral Oil							X						
Petroleum Middle Distillates					X								
Aliphatic Petroleum Distillate		X											
Hydraulic Oil										X			
Compressor Oil													X
Heavy Oil and Gear Oil					X				X				
Photocopy Machine Chemicals			X										
Hydrauli Fluid Tank	X												
Chlorine Tank	X												
Freon 11 Tank	X												
Freon 22 Tank	X												
(USTs)	X										X		
Gasoline (USTs)											X		

Notes:
[A] Bldg Ventilation not operating
[1] Petroleum Distillates assumed to include benzene, toluene, ethylbenzene, xylenes, styrene, cyclohexane
[2] Gasoline assumed to include benzene, toluene, ethylbenzene, xylenes, styrene, cyclohexane

Table H-4
Compounds Identified During Pre-Indoor Air Sampling Inventory

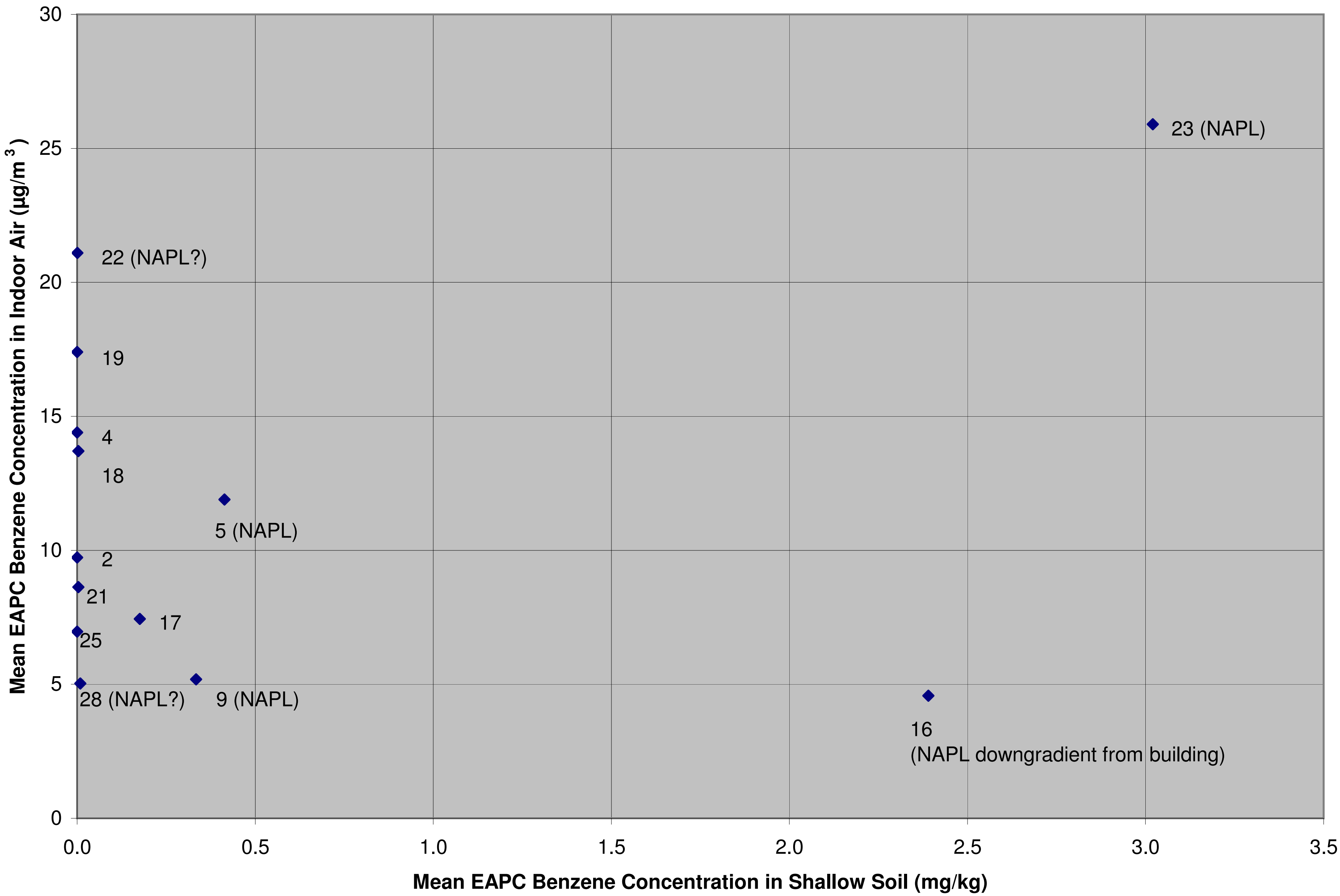
	EAPC												
Compound	2	4	5	9	16	17	18	19	21	22	23	25	28
1,1,1-Trichloroethane					X		X	X	X	X			X
1,1-Dichloroethane													
1,1-Dichloroethene													
Benzene	X	X			X		X			X	X	X	X
Chlorobenzene													
Chloroform													
Cyclohexane	X	X					X			X	X	X	X
Ethylbenzene	X	X					X			X	X	X	X
Methyl Ethyl Ketone	X	X					X	X					
Methylene Chloride		X	X							X			X
Styrene	X	X					X			X	X	X	X
Tetrachloroethene					X				X	X			X
Toluene	X	X		X	X	X	X	X	X	X	X	X	X
Trichloroethene													
Xylenes	X	X		X	X	X	X	X	X	X	X	X	X

Table H-5
Literature Review of Background Indoor Air Concentrations for Volatile Organic Compounds

Chemical	Typical Literature Review Value	1992 CARB Indoor Air Study			Shah and Singh, 1988	EPA Inside IAQ, 1998	Kurtz & Folkes, 2002.			CDOT MTL, 2002	Sexton et al., 2004		
		Mean	Max	Min	Mean	"Typical Value"	Median	95% UCL	Max	Mean (range)	Median	10 %ile	90 %ile
1,1-Dichloroethane	-	-	-	-	-	-	<0.08	<0.08	0.16	<0.08	-	-	-
1,1- Dichloroethene	-	-	-	-	-	-	<0.04	<0.04	<0.04	0.01	-	-	-
1,1,1-Trichloroethane	1	7	92	0.054	270	-	0.86	2.5	210	0.70 – 1.67	-	-	-
1,2 Dichloroethane	0.07	-	-	-	-	-	0.04	0.07	0.72	0.069 – 0.085	-	-	-
Benzene	4	4.4	130	0.19	16.5	5	-	-	-	3.5 - 4.4	1.9	0.8	15.3
Carbon Tetrachloride	0.5	-	-	-	-	-	-	-	-	-	0.5	0.4	0.9
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	1	1.2	3.9	0.59	4.1	1	-	-	-	1.9 - 4.4	0.9	0.1	3.4
Cyclohexane	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	2	-	-	-	12.5	5	-	-	-	-	1.4	0.5	8.9
Methyl Ethyl Ketone	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	1	82	1700	1.4	-	10	0.88	4.5	180	1.1 – 2.2	1.1	0.2	11.5
Styrene	1	2.4	140	0.089	-	-				-	0.5	0.1	1.4
Tetrachloroethene	1	1.4	30	0.13	21	5	1	2.2	440	1.4 – 8.8	0.6	0.2	3.8
Toluene	10	-	-	-	28	20	-	-	-	-	12.3	2.4	53.8
Trichloroethene	1	0.64	9.1	0.16	7.2	5	0.13	0.22	27	0.13 – 0.58	0.2	0	0.8
Vinyl Chloride	0.01	-	-	-	-	-	0.01	0.02	0.5	0.011 – 0.017	-	-	-
Xylenes	20	25	400	0.58	50	15	-	-	-	-	6.4	2.2	48.3

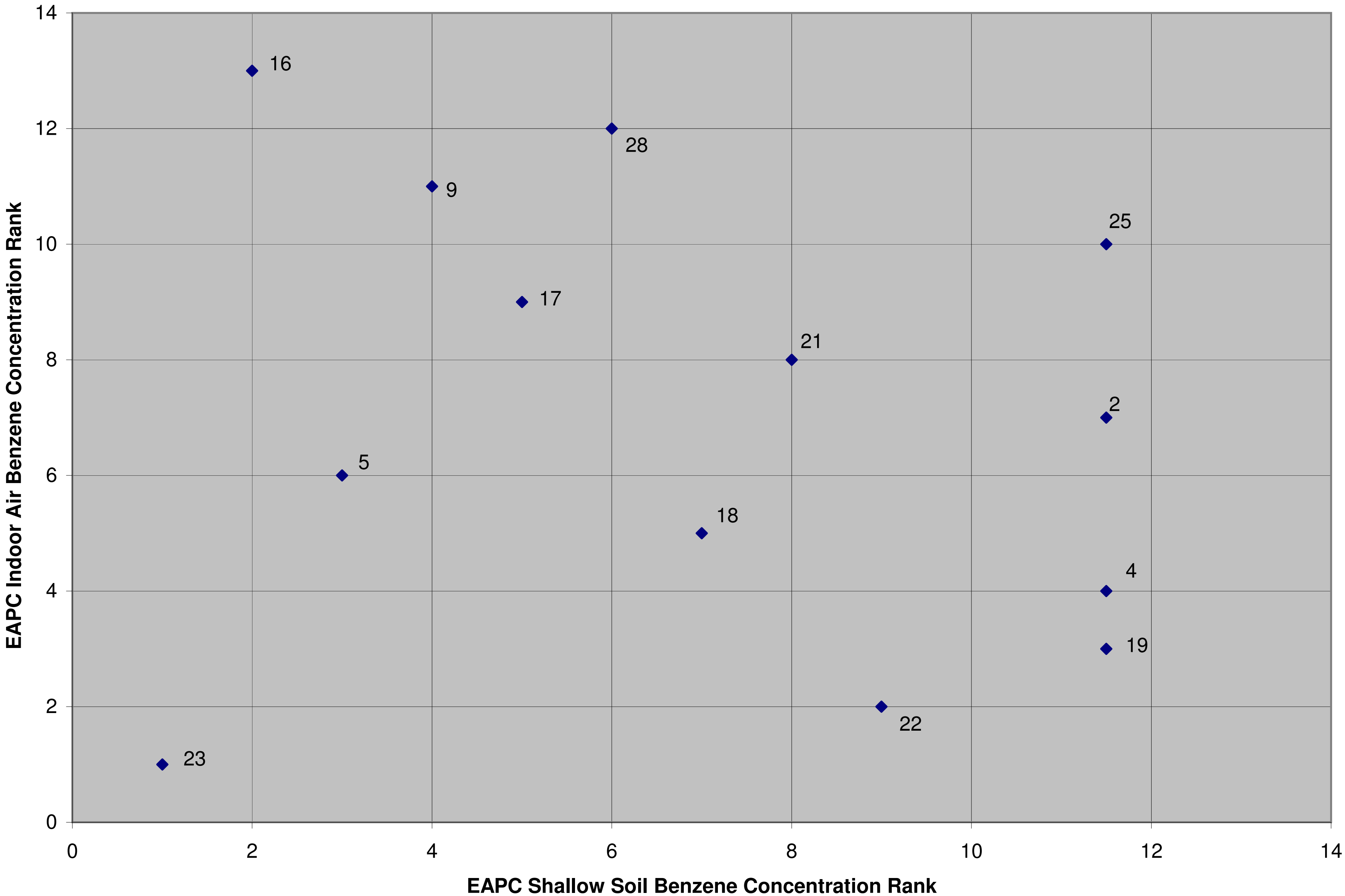
All Concentrations reported in ug/m^3

FIGURE H-1



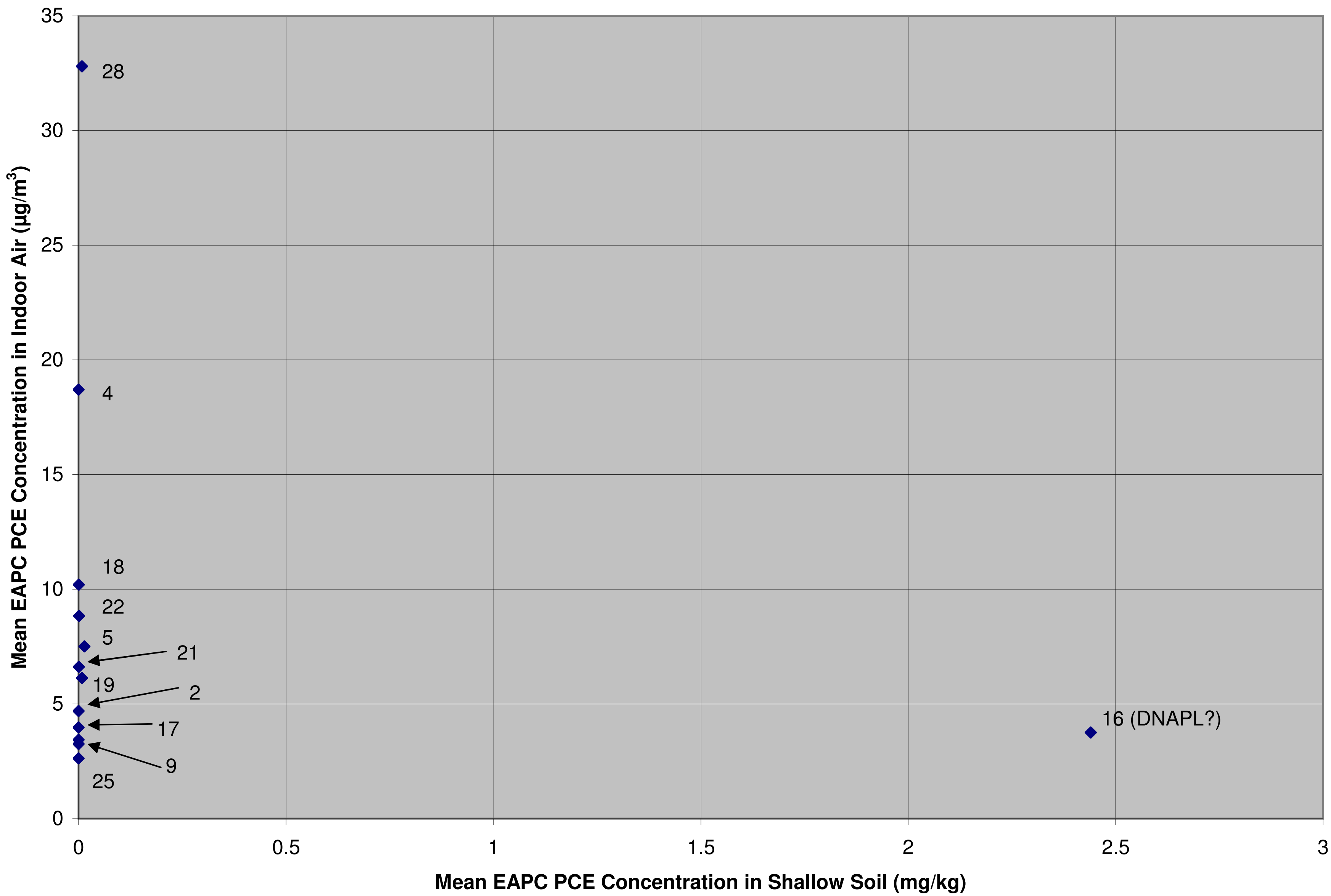
30
25
20
15
10
5
0
Mean EAPC Benzene Concentration in Indoor Air (µg/m 3)
23 (NAPL)
22 (NAPL?)
19
4
18
5 (NAPL)
2
21
17
25
28 (NAPL?)
9 (NAPL)
16
(NAPL downgradient from building)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Mean EAPC Benzene Concentration in Shallow Soil (mg/kg)

FIGURE H-2



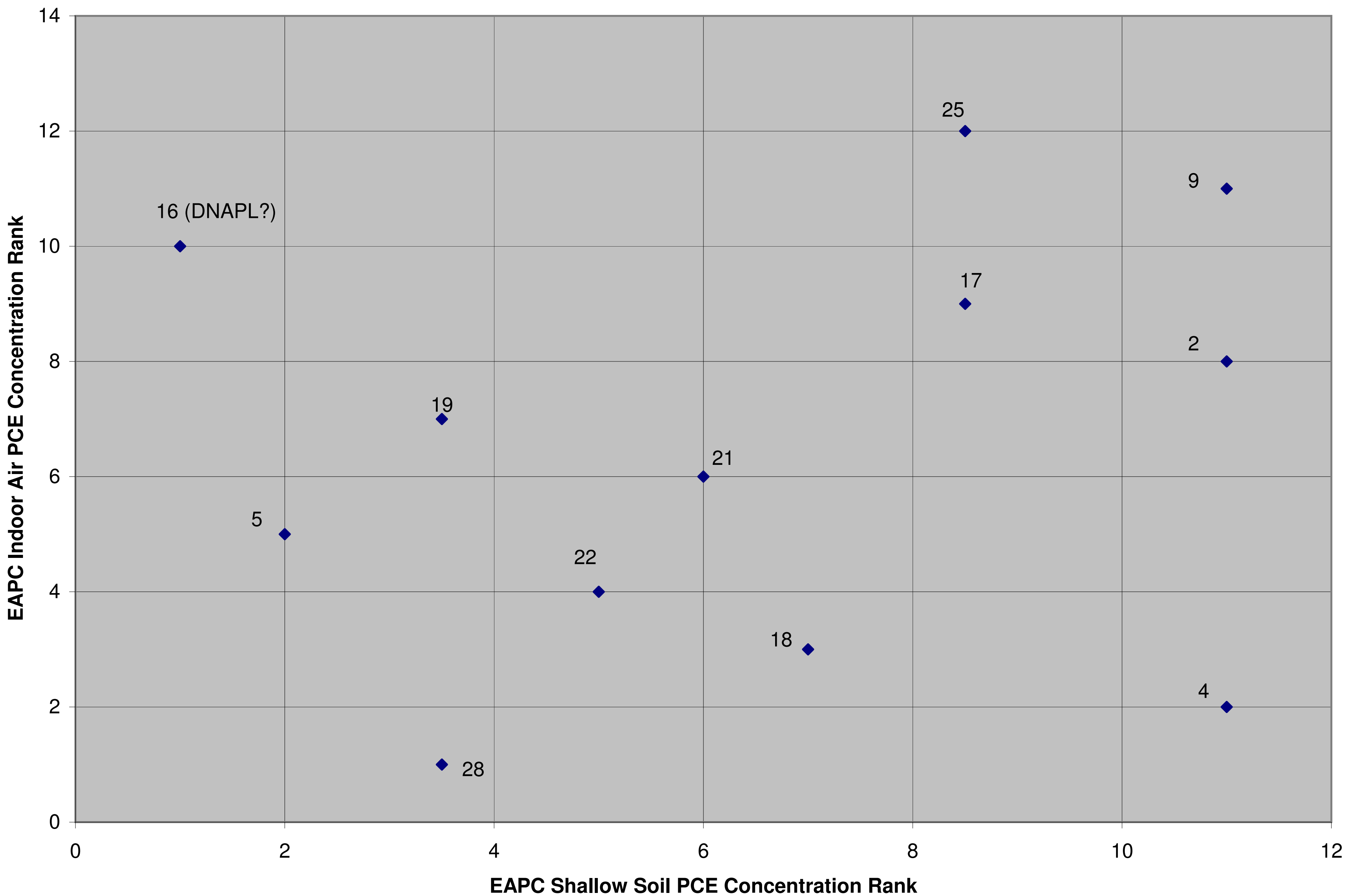
14
12
10
8
6
4
2
0
EAPC Indoor Air Benzene Concentration Rank
16
28
9
25
17
21
2
5
18
4
19
22
23
0
2
4
6
8
10
12
14
EAPC Shallow Soil Benzene Concentration Rank

FIGURE H-3



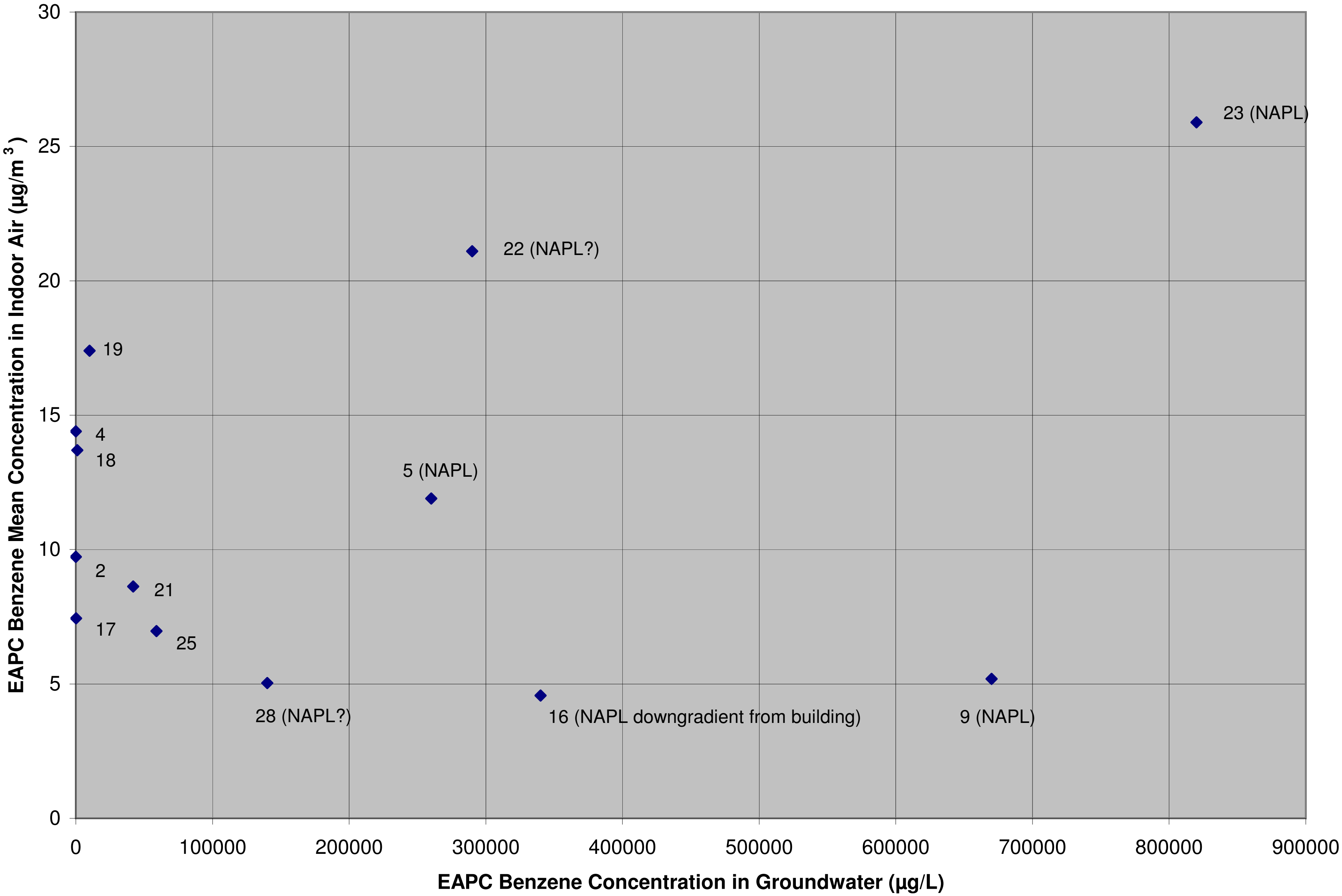
Mean EAPC PCE Concentration in Indoor Air (µg/m3)
Mean EAPC PCE Concentration in Shallow Soil (mg/kg)
0
5
10
15
20
25
30
35
0
0.5
1
1.5
2
2.5
3
28
4
18
22
5
21
19
2
17
9
25
16 (DNAPL?)

FIGURE H-4



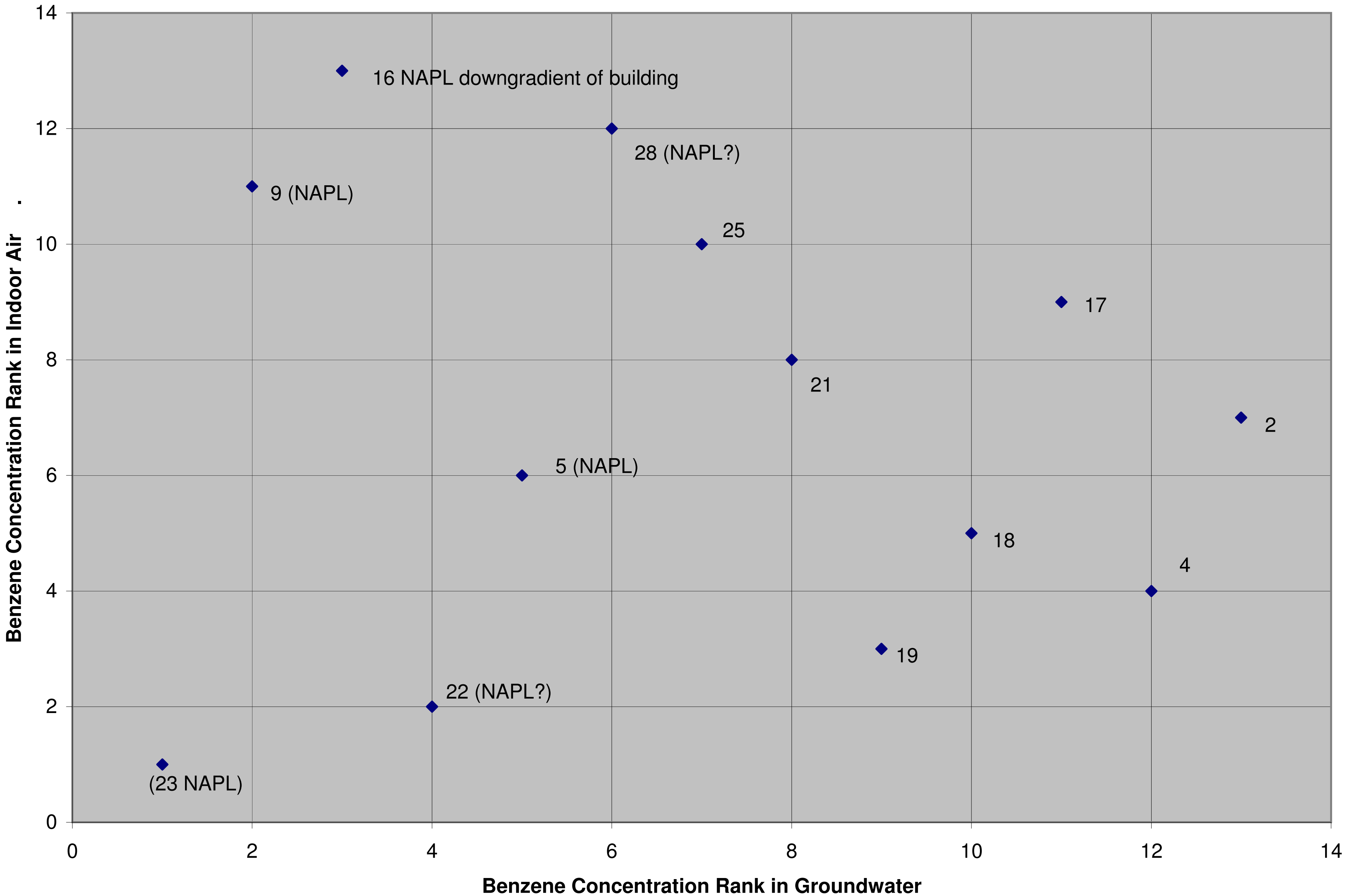
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
EAPC Indoor Air PCE Concentration Rank
EAPC Shallow Soil PCE Concentration Rank
25
9
16 (DNAPL?)
17
2
19
21
5
22
18
4
28

FIGURE H-5



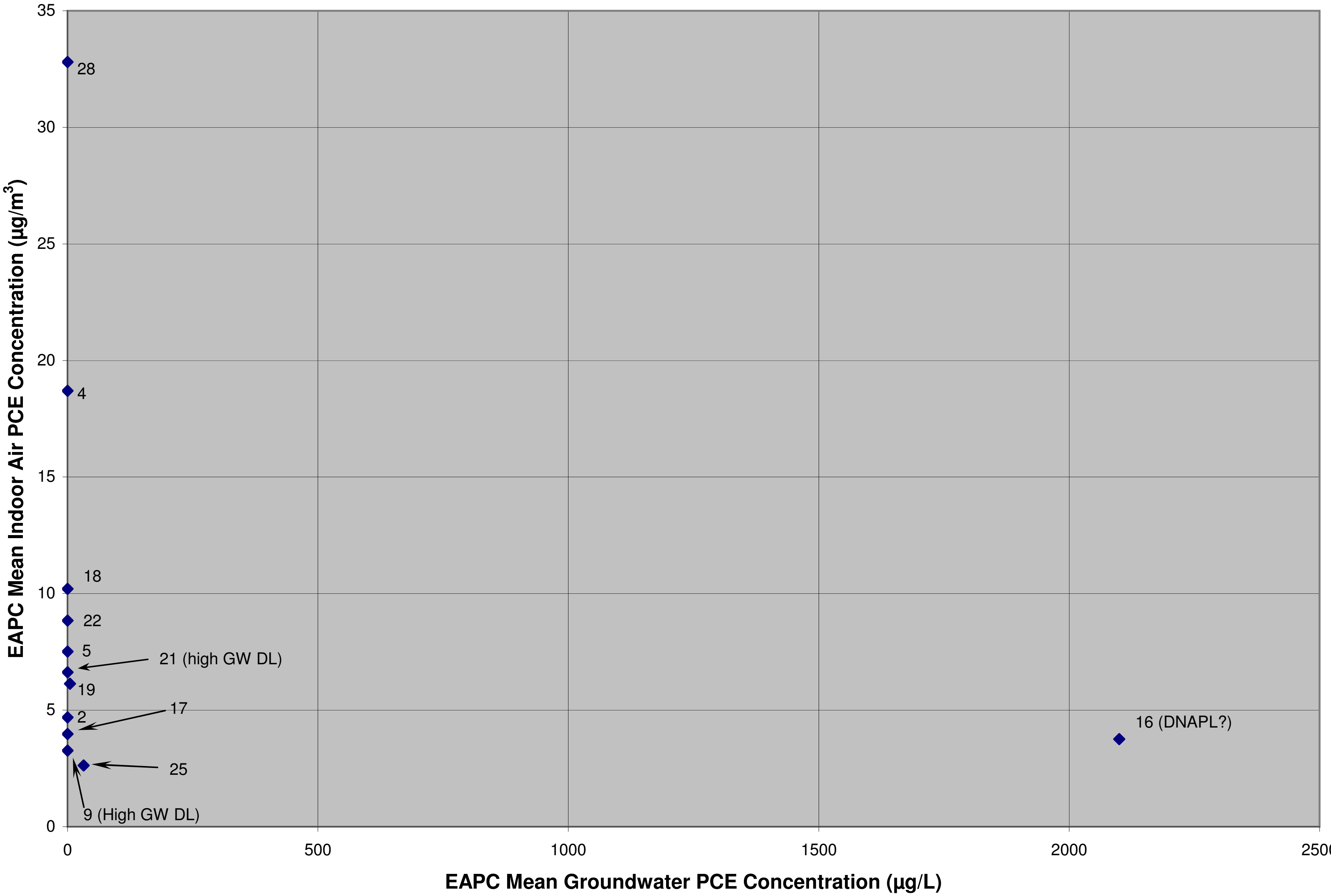
23 (NAPL)
22 (NAPL?)
19
4
18
5 (NAPL)
2
21
17
25
28 (NAPL?)
16 (NAPL downgradient from building)
9 (NAPL)
0
5
10
15
20
25
30
0
100000
200000
300000
400000
500000
600000
700000
800000
900000
EAPC Benzene Mean Concentration in Indoor Air (µg/m³)
EAPC Benzene Concentration in Groundwater (µg/L)

FIGURE H-6



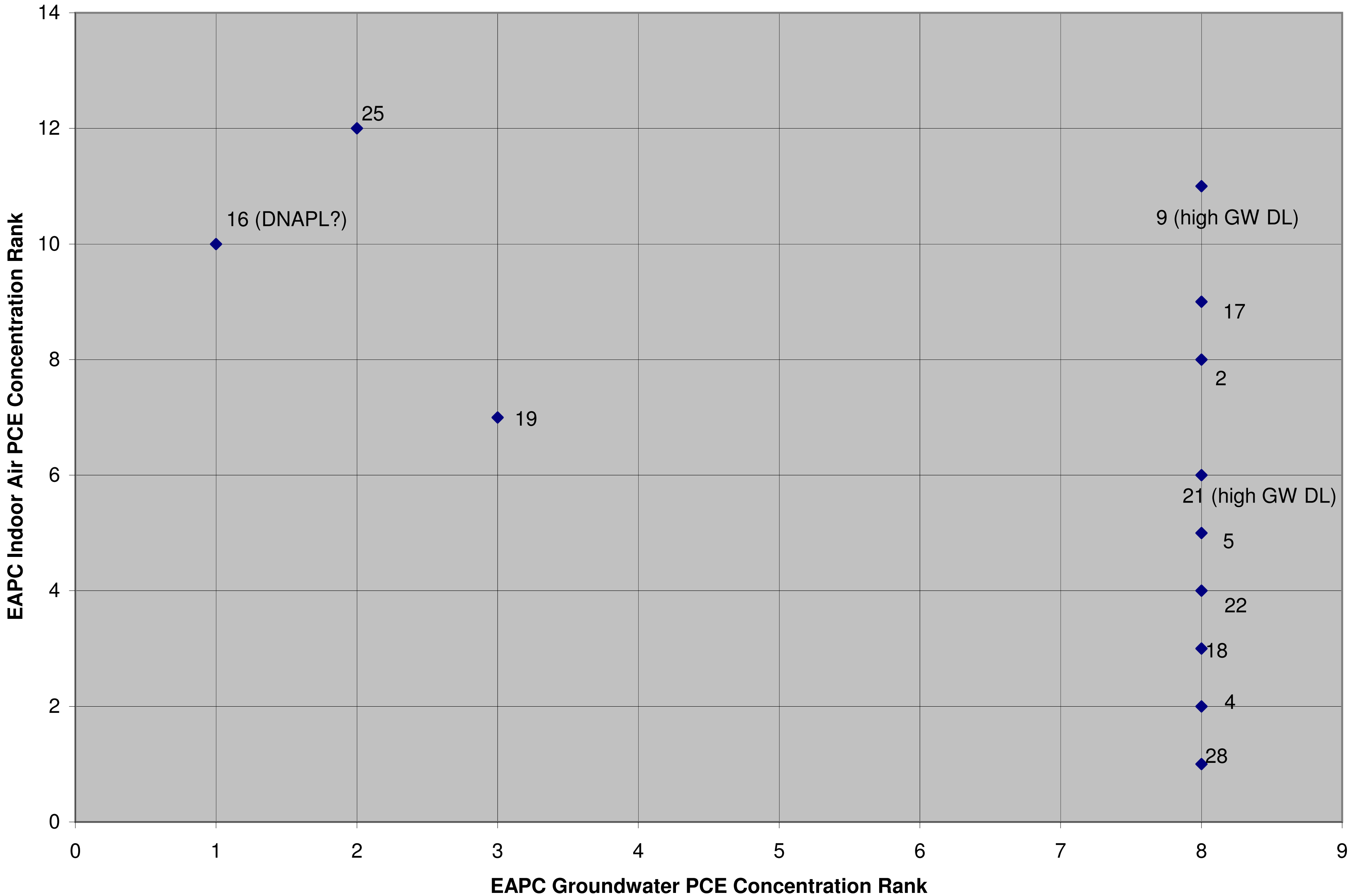
Benzene Concentration Rank in Indoor Air
Benzene Concentration Rank in Groundwater
16 NAPL downgradient of building
28 (NAPL?)
9 (NAPL)
25
17
21
2
5 (NAPL)
18
4
19
22 (NAPL?)
(23 NAPL)
0
2
4
6
8
10
12
14

FIGURE H-7



35
30
25
20
15
10
5
0
28
4
18
22
5
21 (high GW DL)
19
17
2
25
9 (High GW DL)
16 (DNAPL?)
0
500
1000
1500
2000
2500
EAPC Mean Indoor Air PCE Concentration (µg/m3)
EAPC Mean Groundwater PCE Concentration (µg/L)

FIGURE H-8



14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
EAPC Indoor Air PCE Concentration Rank
EAPC Groundwater PCE Concentration Rank
25
16 (DNAPL?)
19
9 (high GW DL)
17
2
21 (high GW DL)
5
22
18
4
28

Figure H-9
1,1,1-Trichloroethane

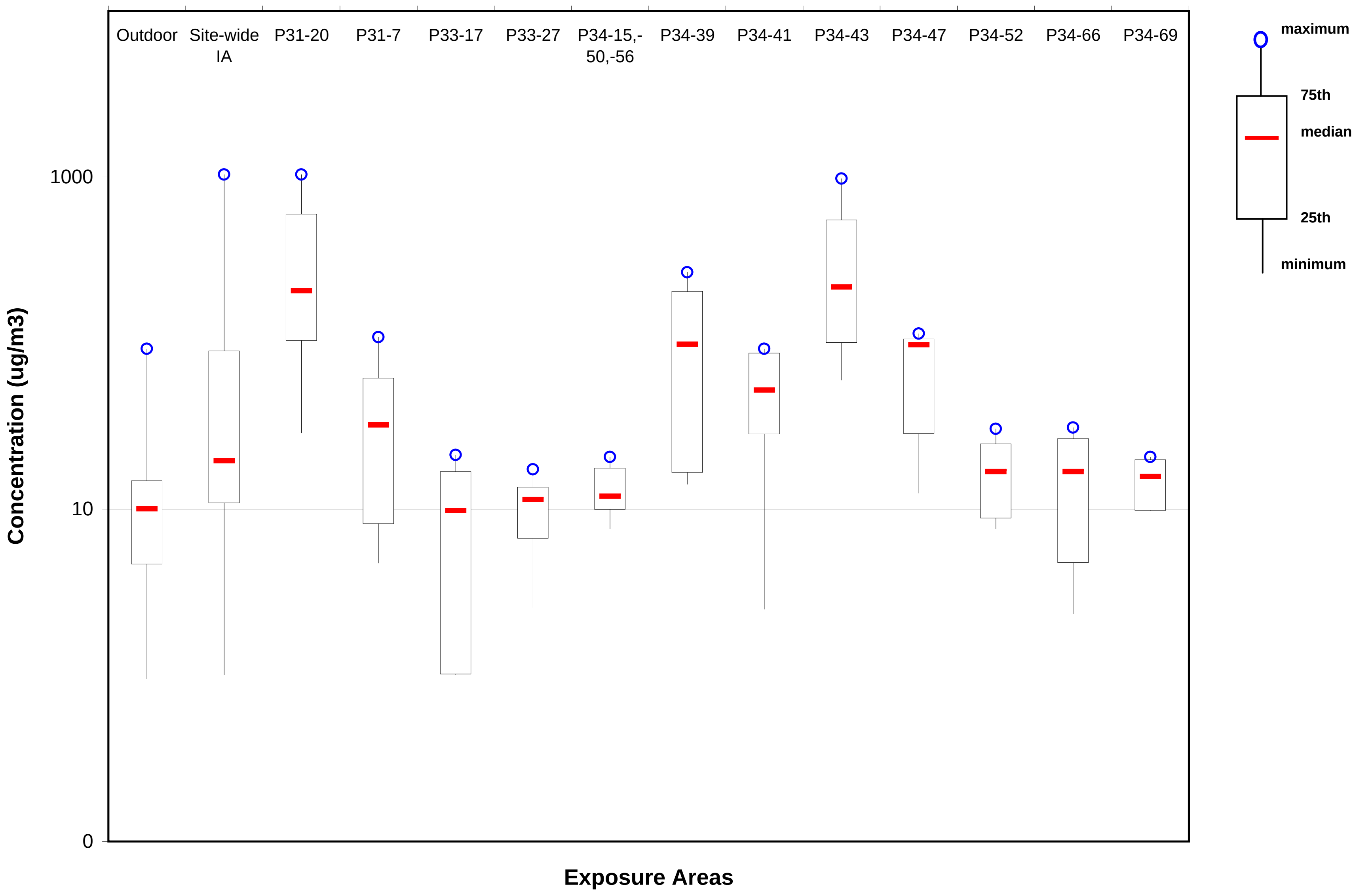


Figure H-10
1,1-Dichloroethane

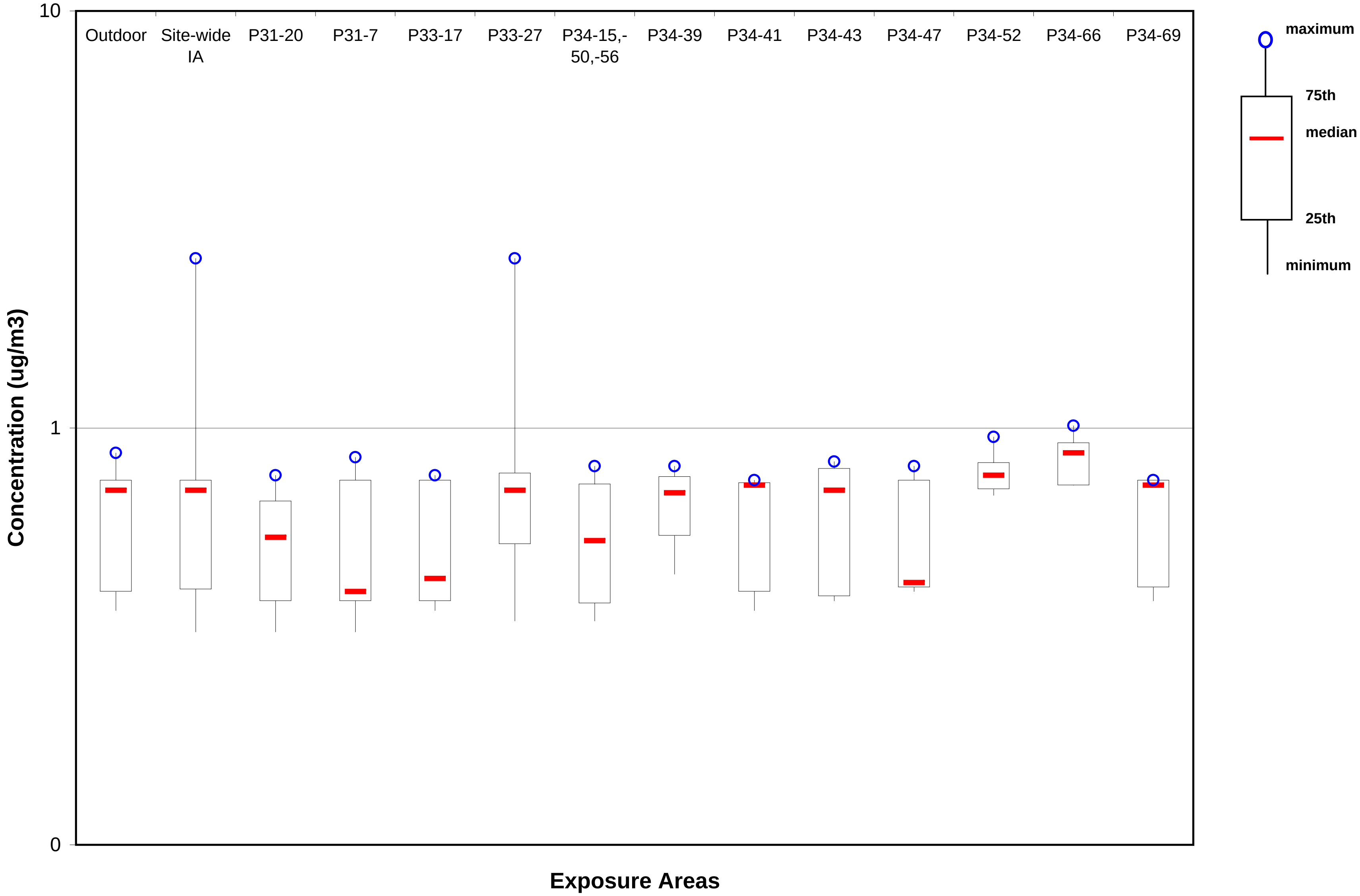


Figure H-11
1,1-Dichloroethene

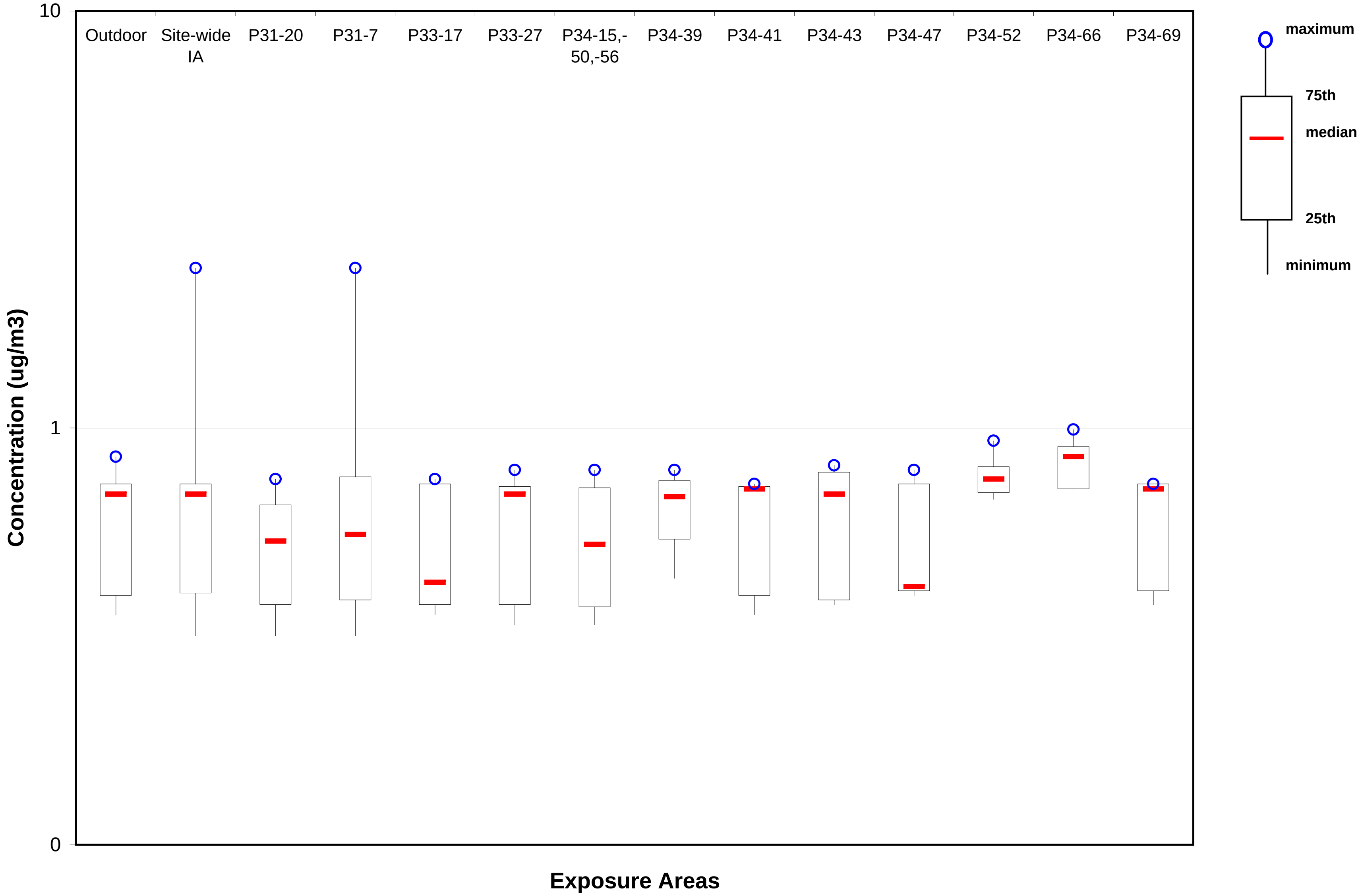


Figure H-12
1,2-Dibromoethane

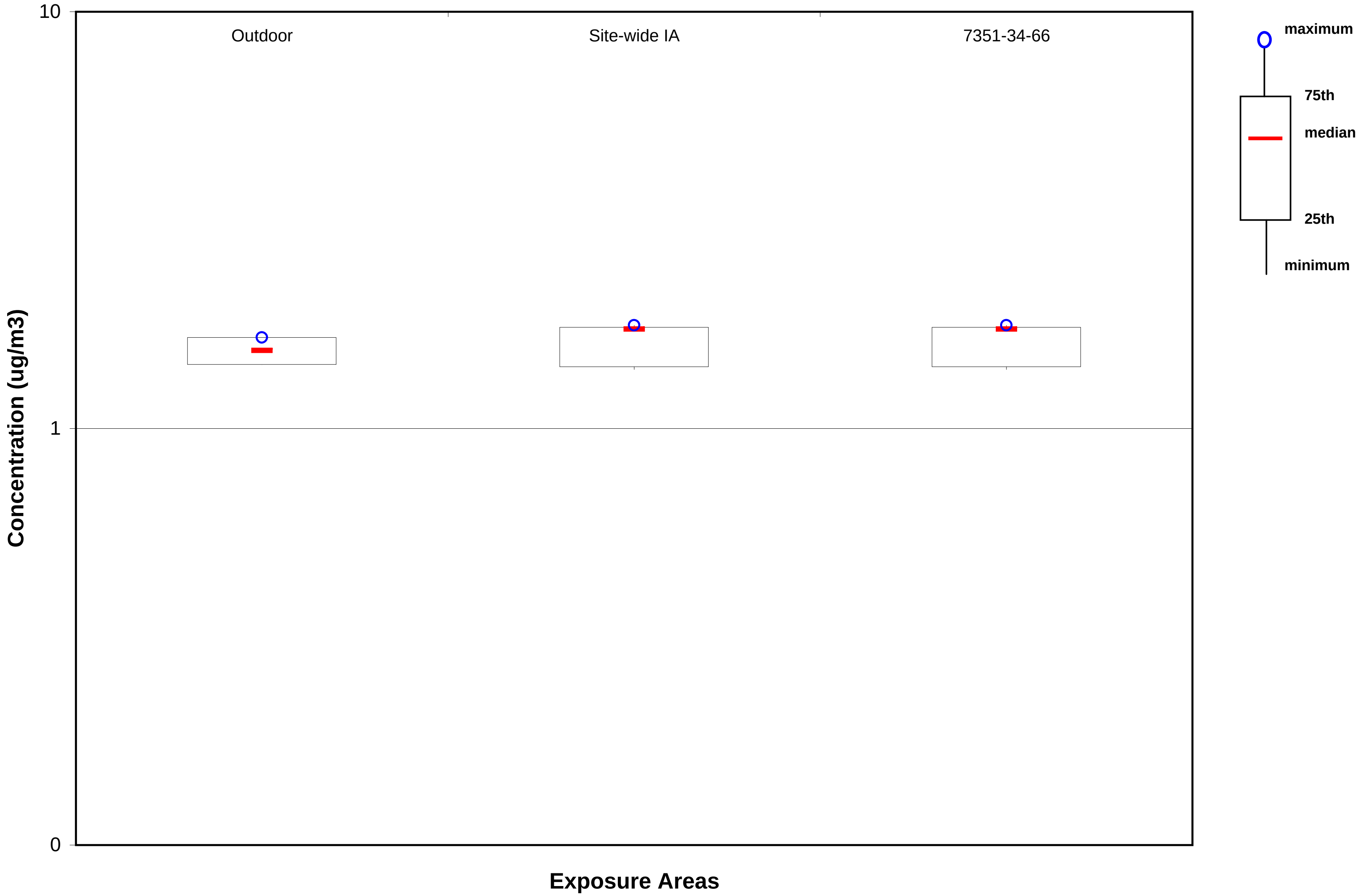


Figure H-13
1,2-Dichloroethane

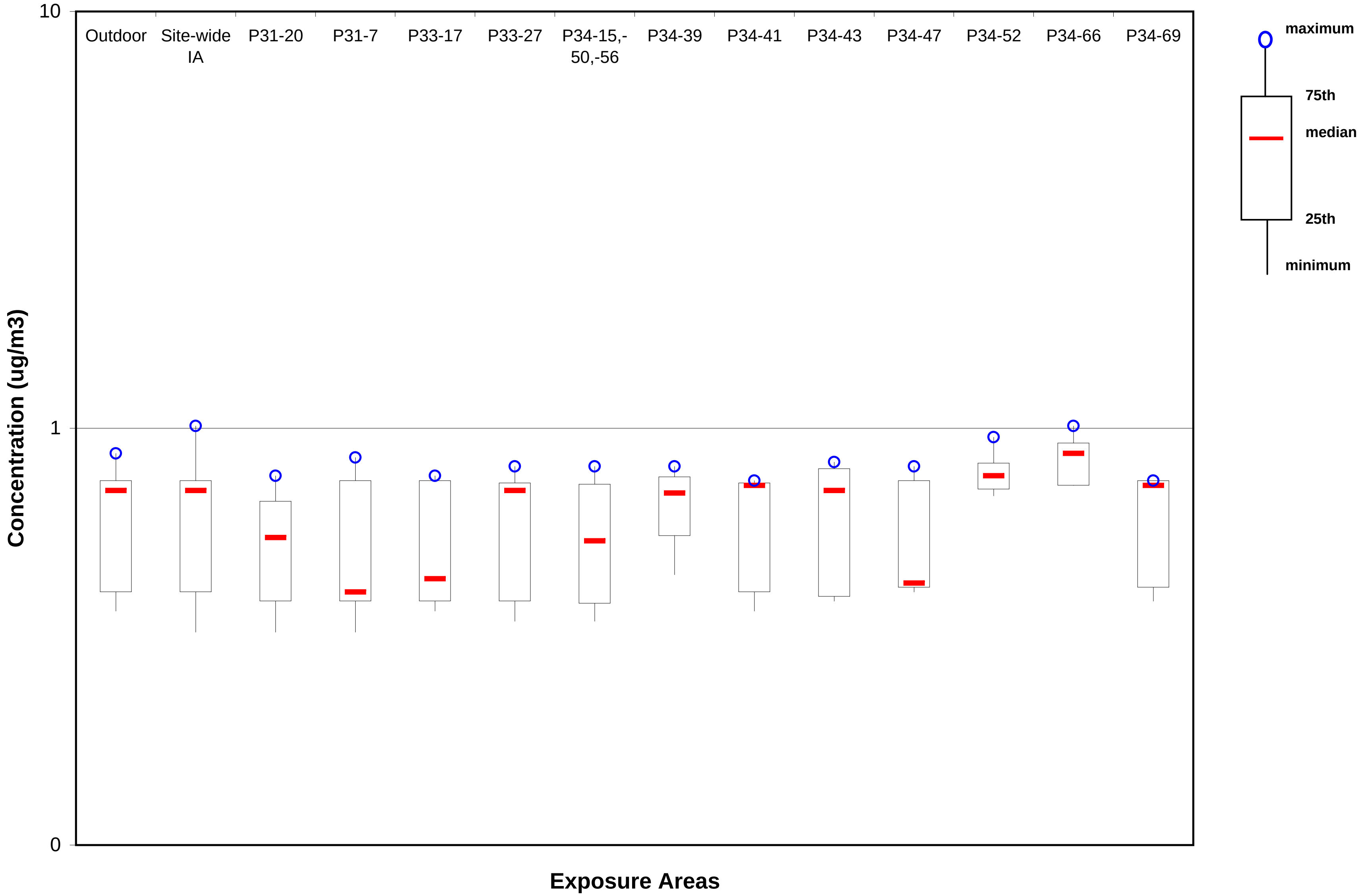


Figure H-14
1,2-Dichloroethene

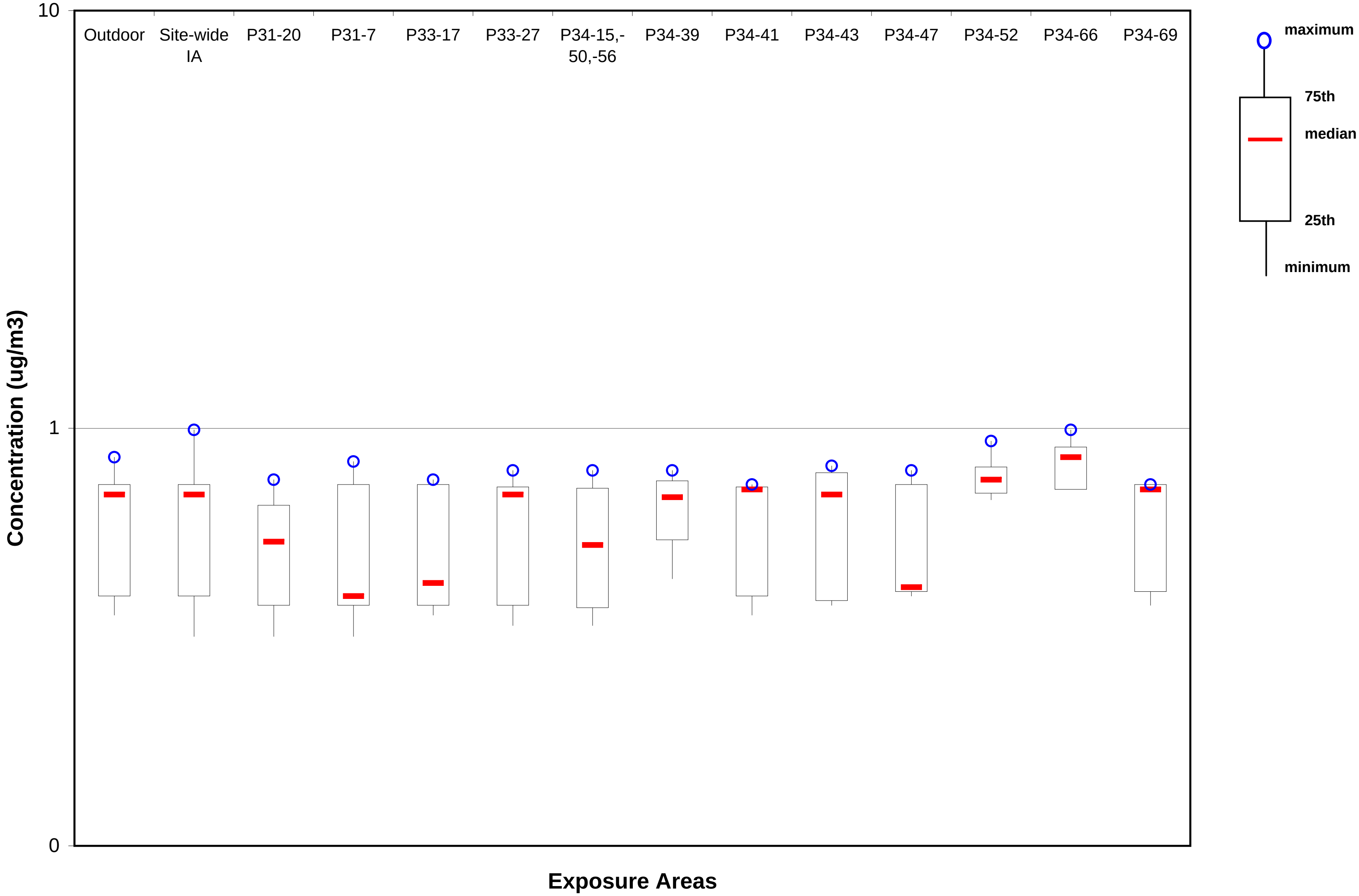


Figure H-15
Cis-1,2-Dichloroethene

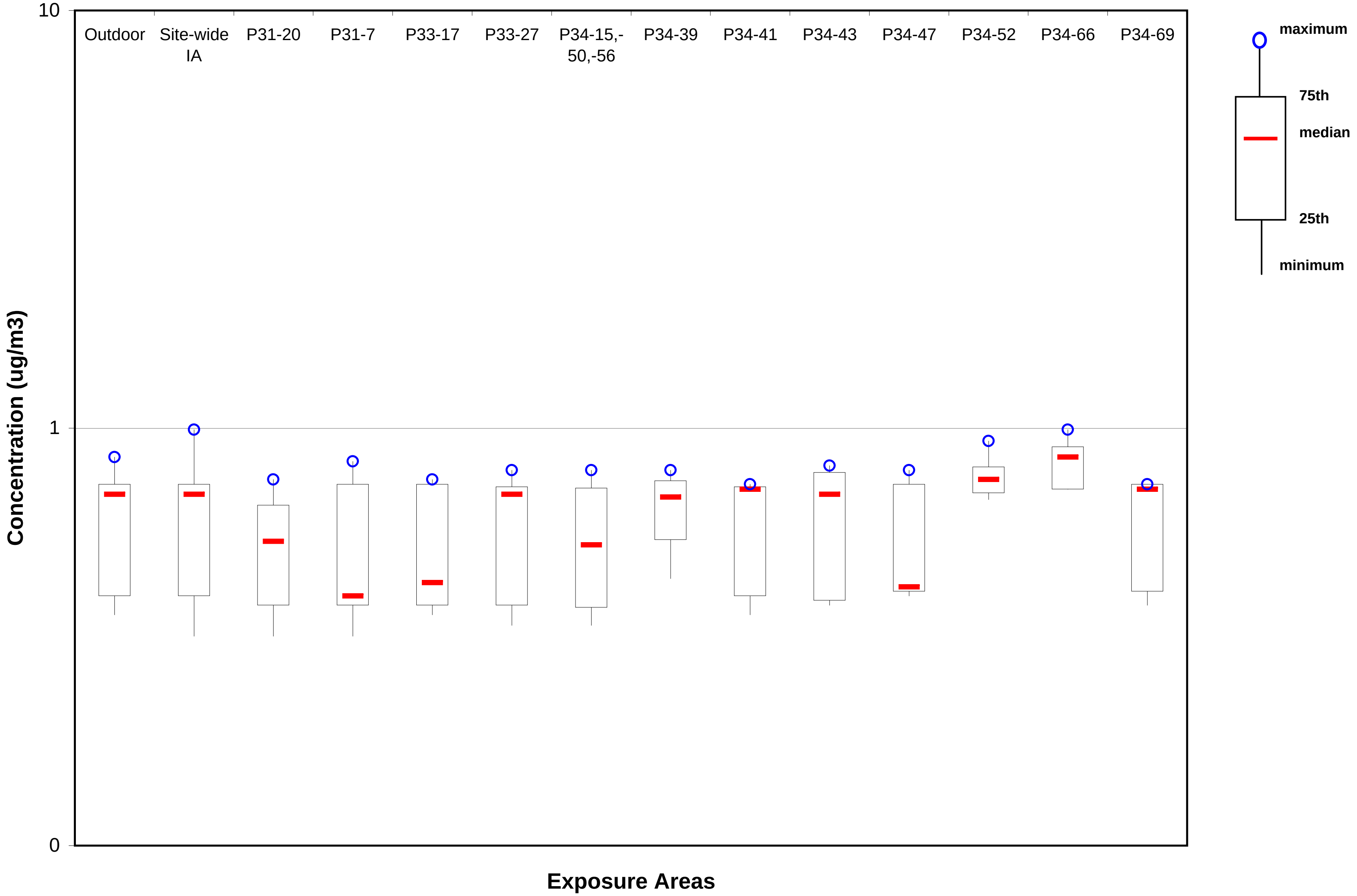


Figure H-16
Trans-1,2-Dichloroethene

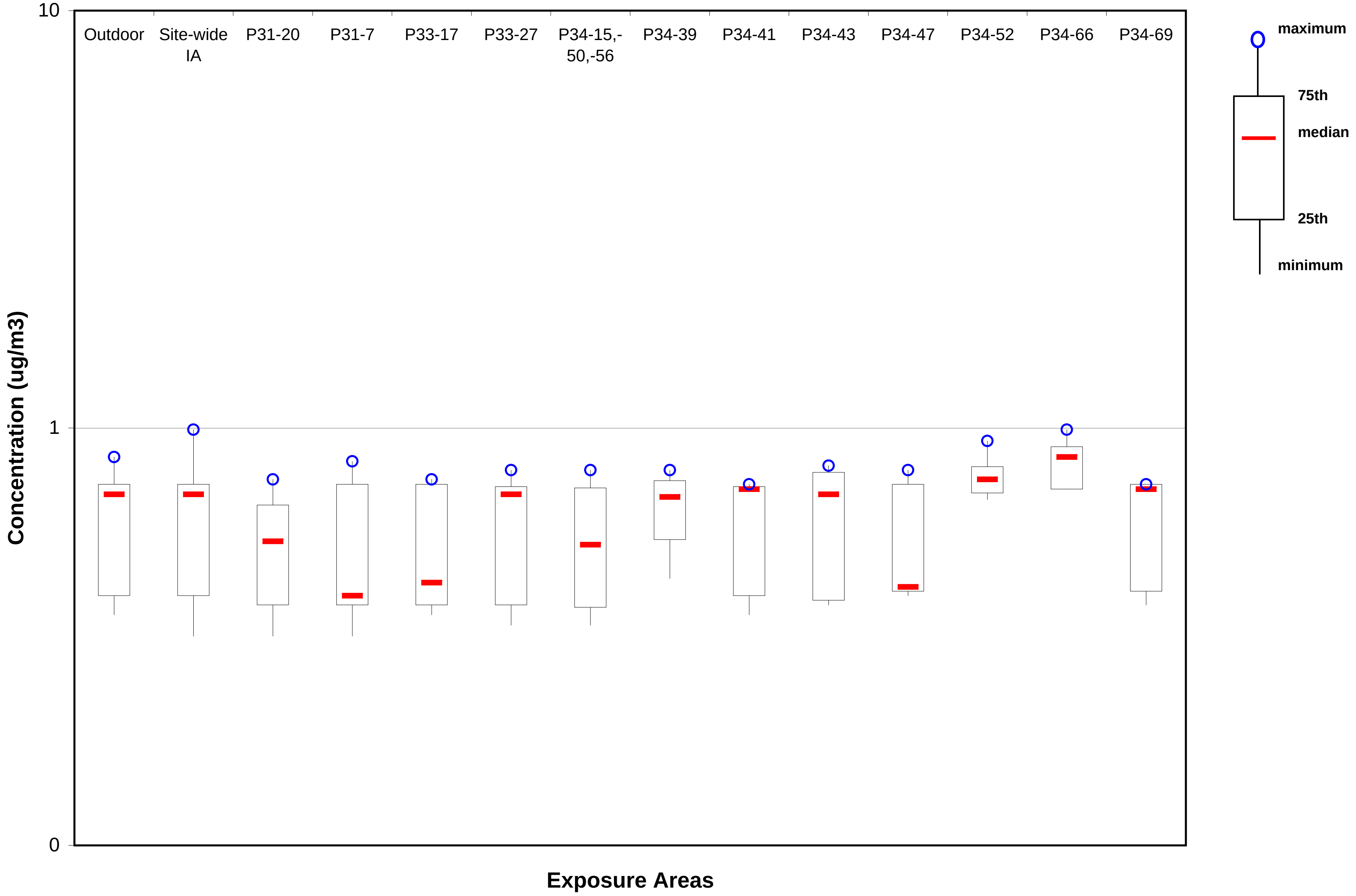


Figure H-17
Acetonitrile

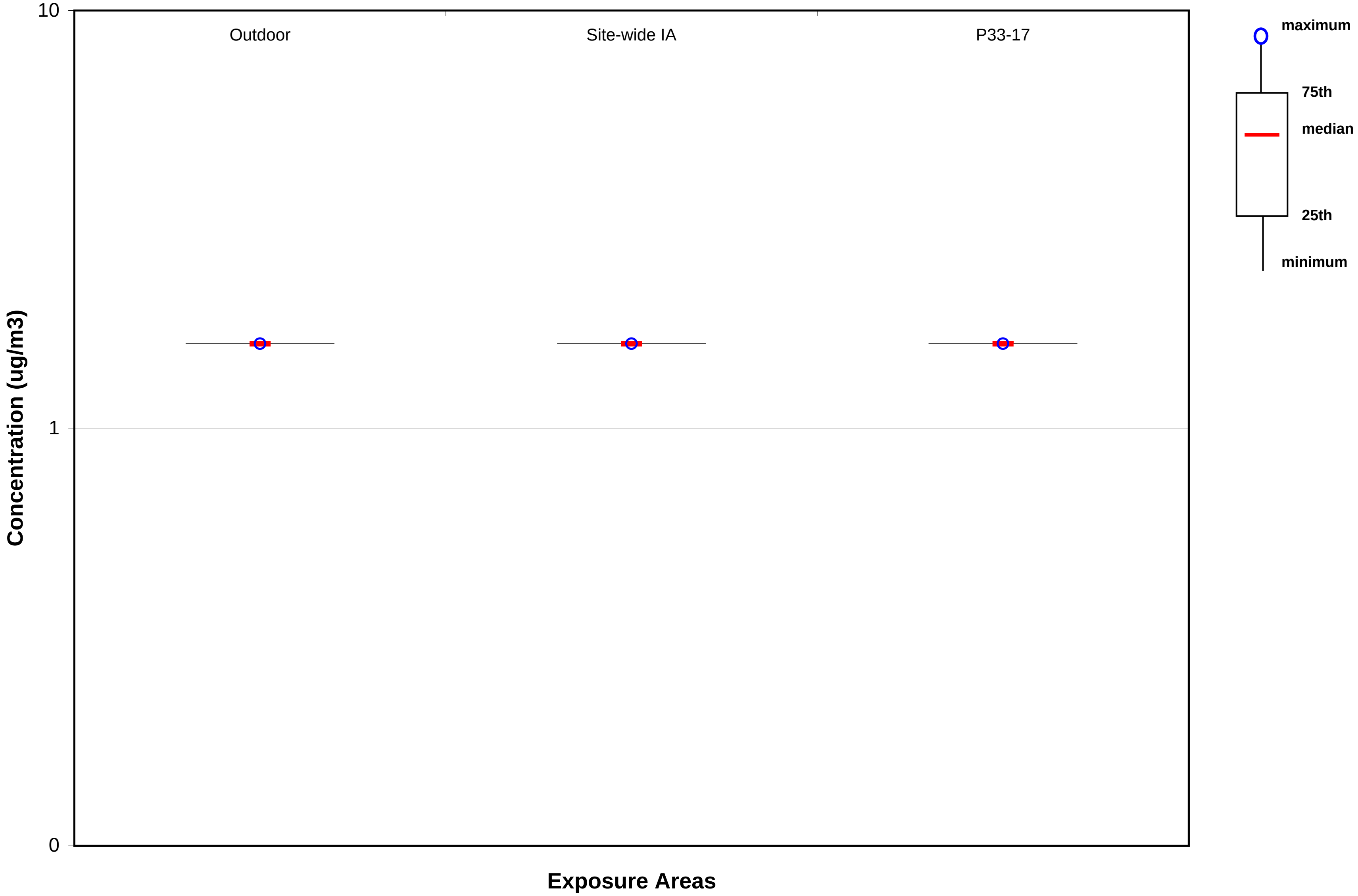


Figure H-18
Benzene

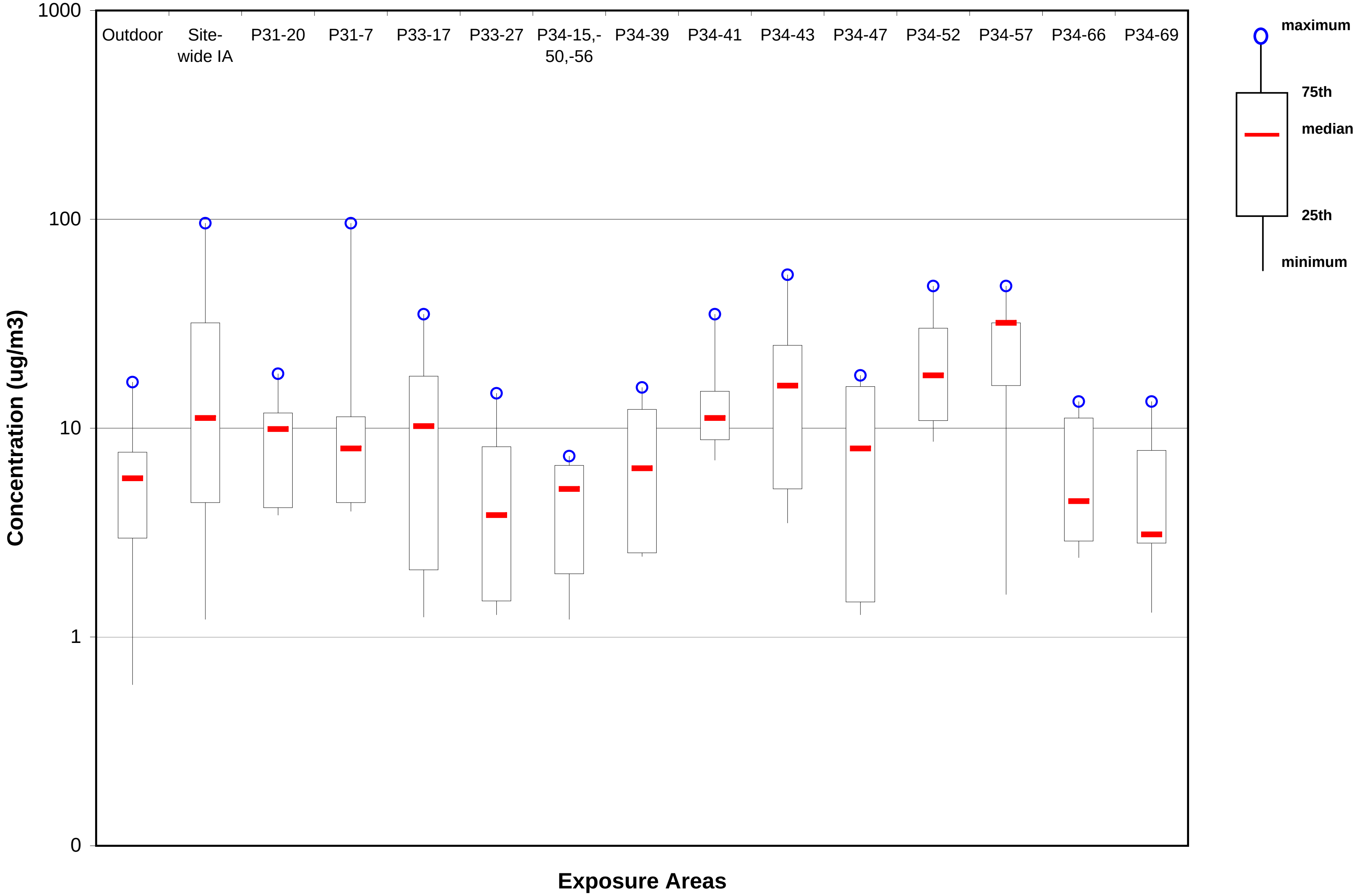


Figure H-19
Chlorobenzene

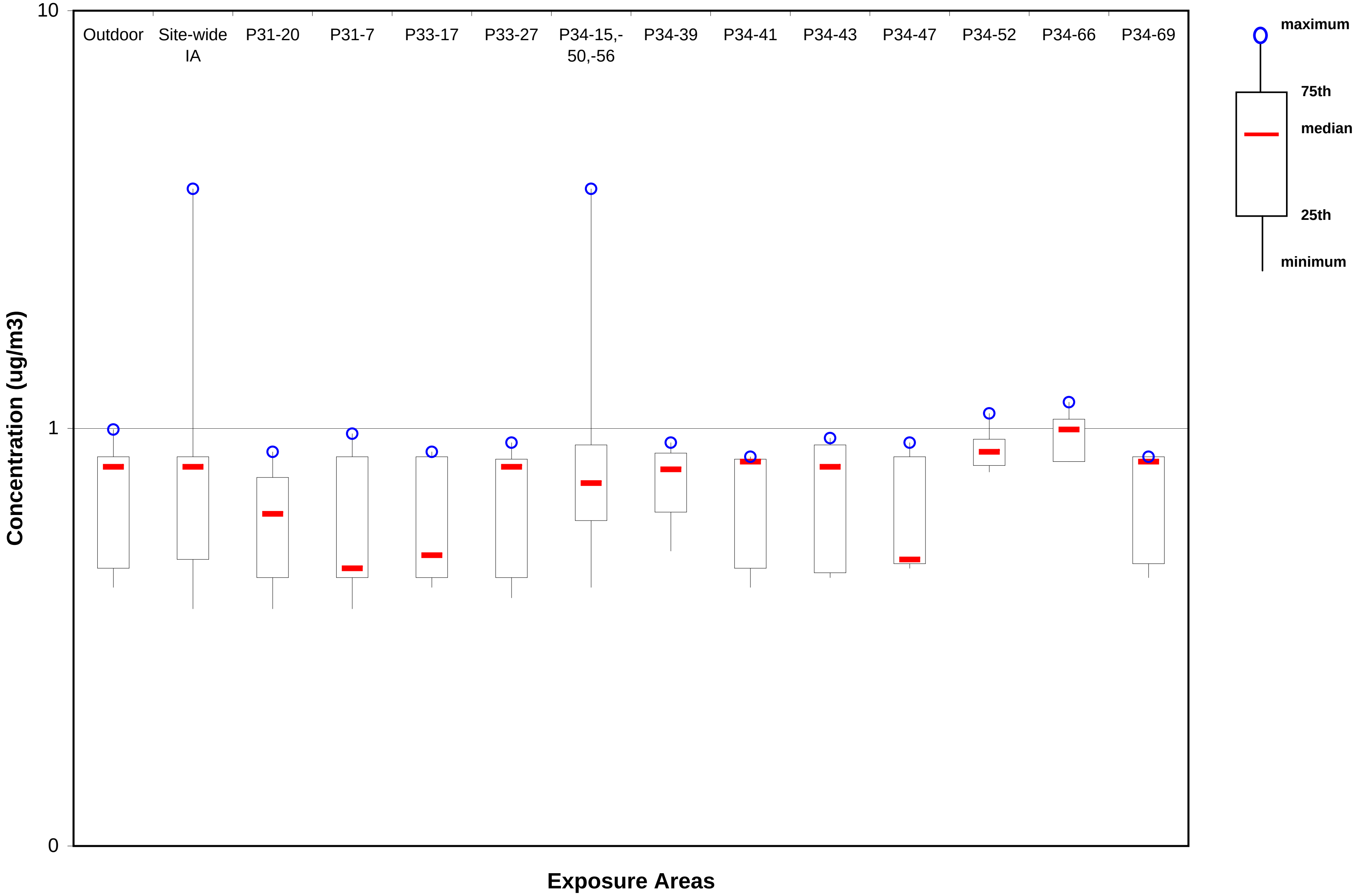


Figure H-20
Chloroform

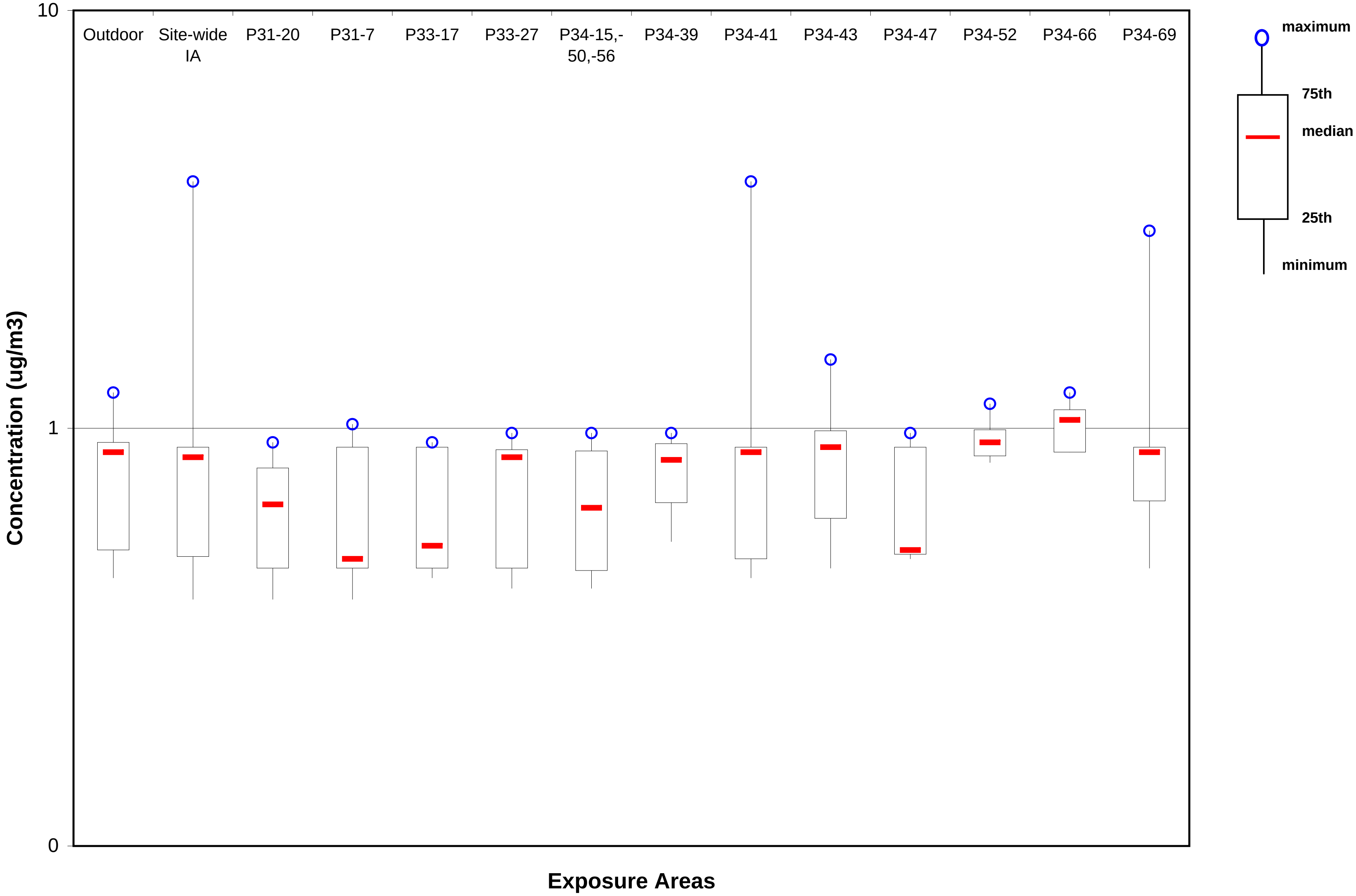


Figure H-21
Cyclohexane

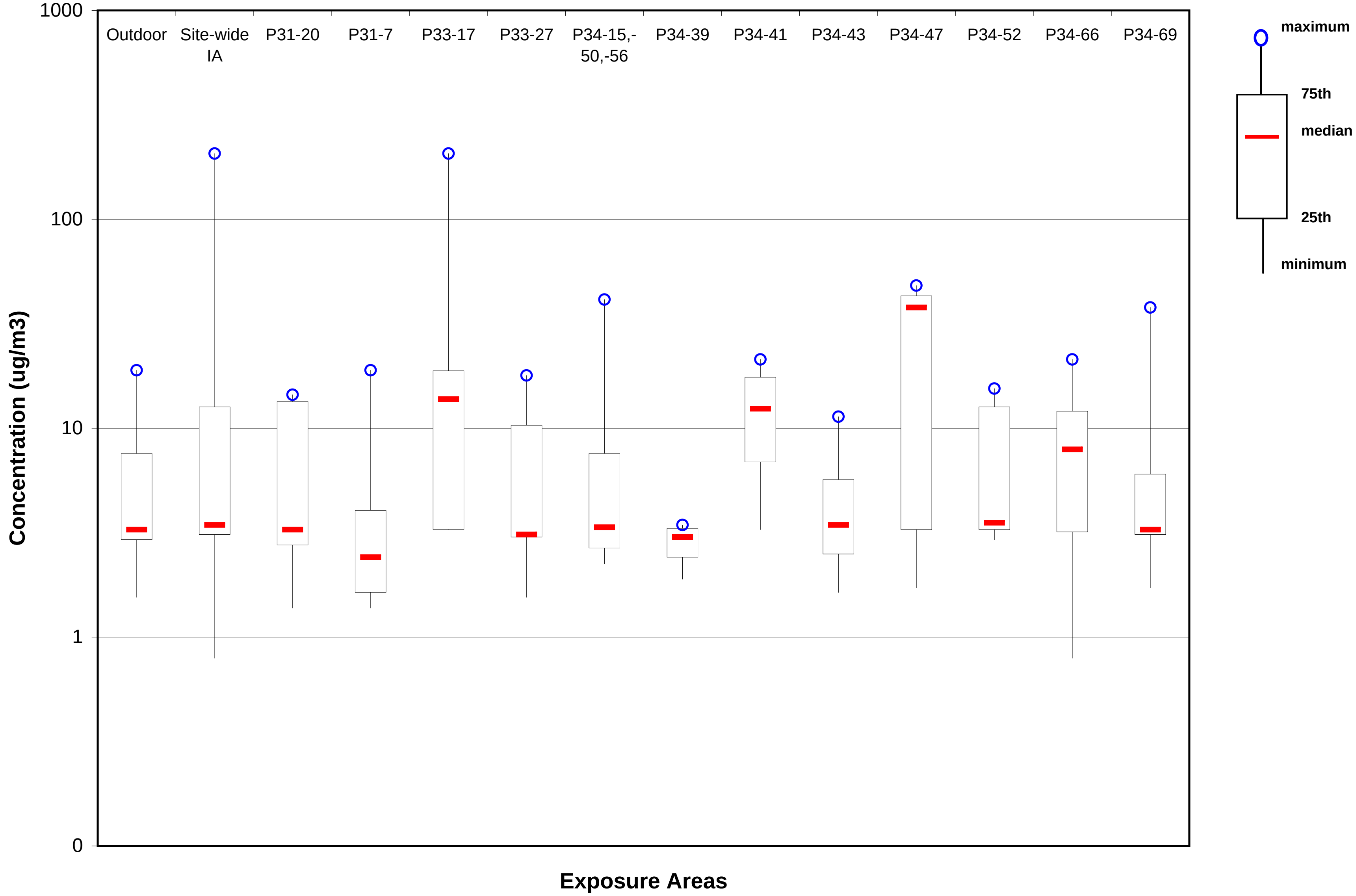


Figure H-22
Ethylbenzene

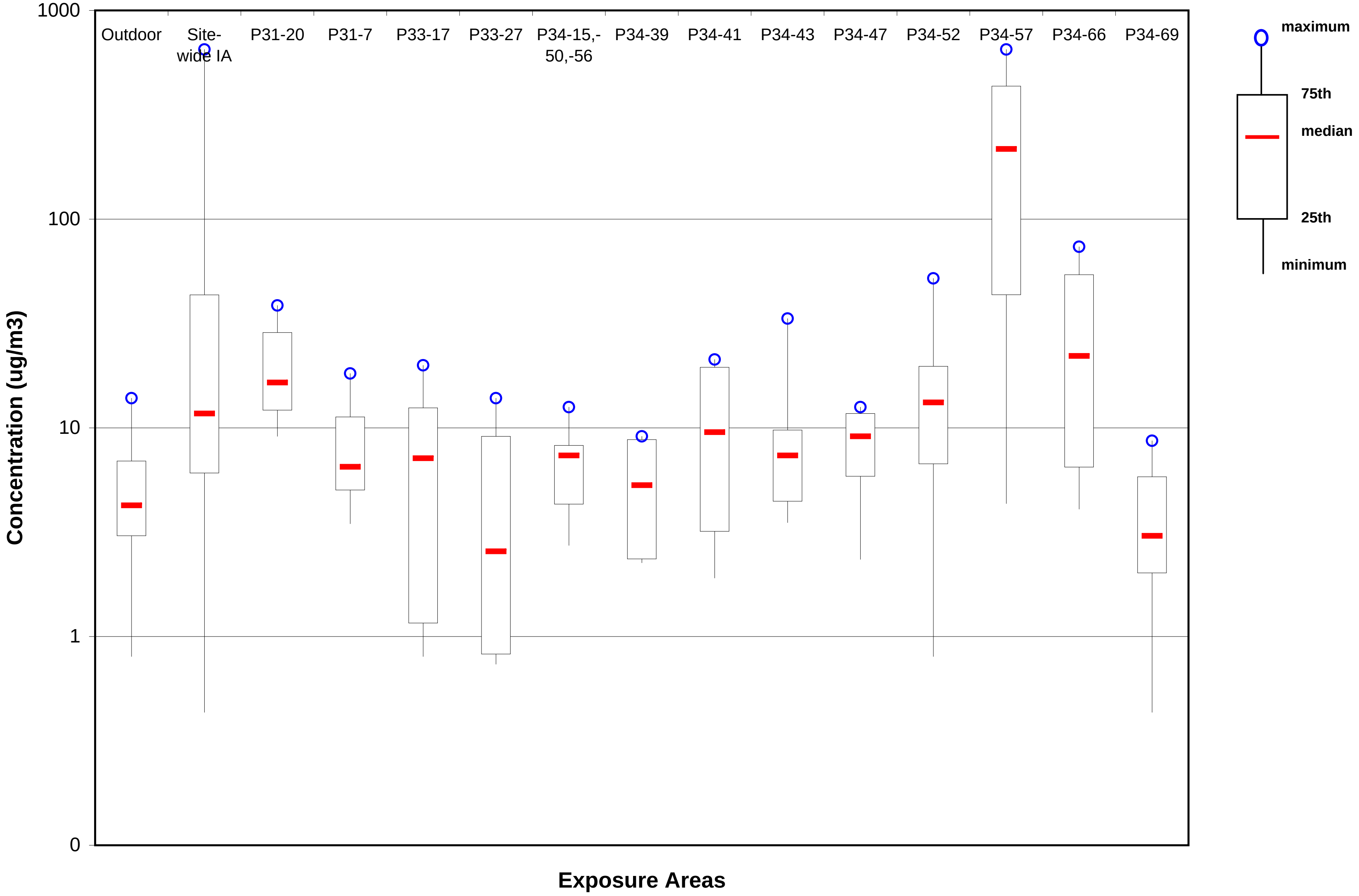


Figure H-23
Methyl Ethyl Ketone

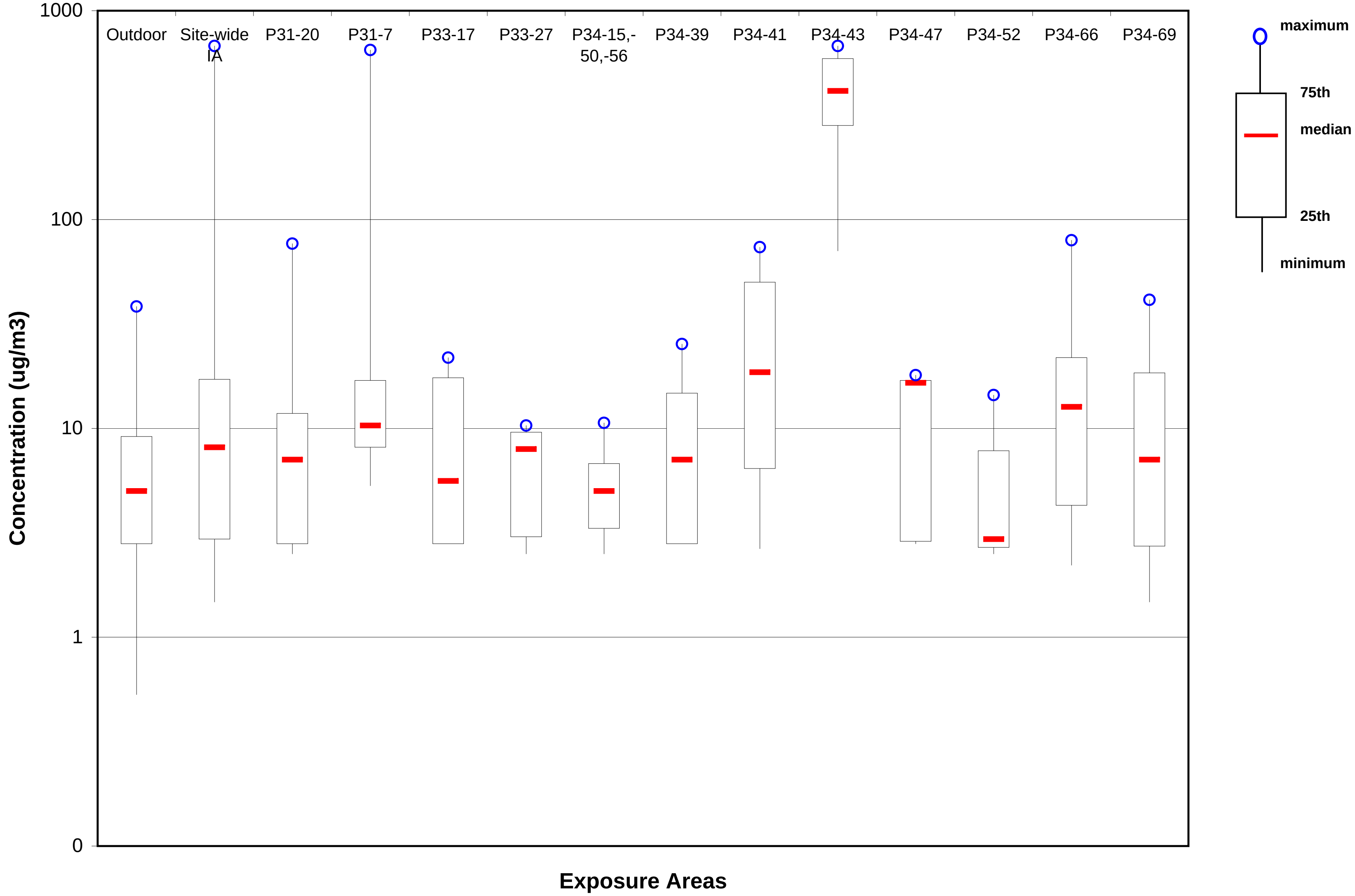


Figure H-24
Methylene Chloride

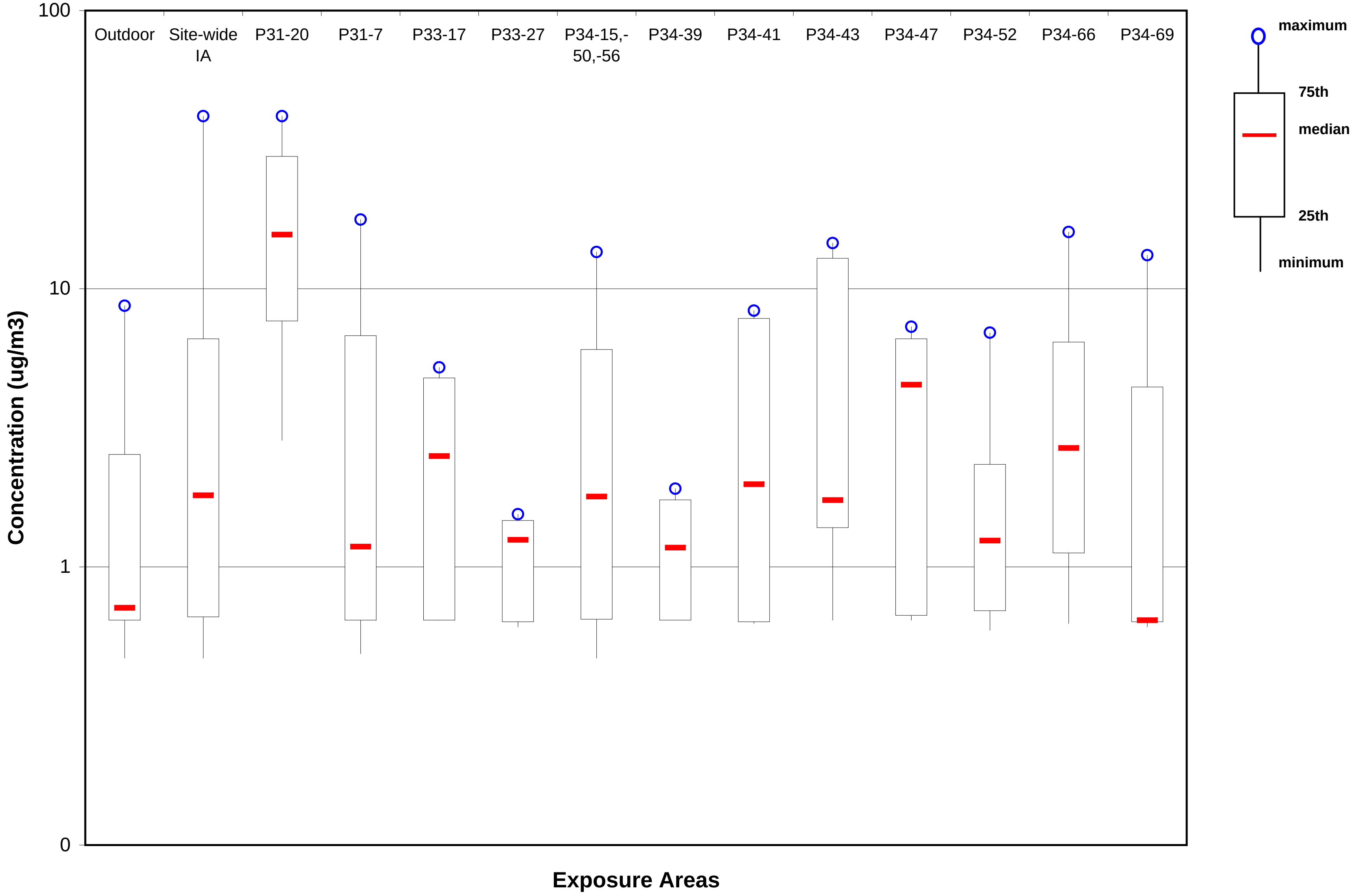


Figure H-25
Styrene

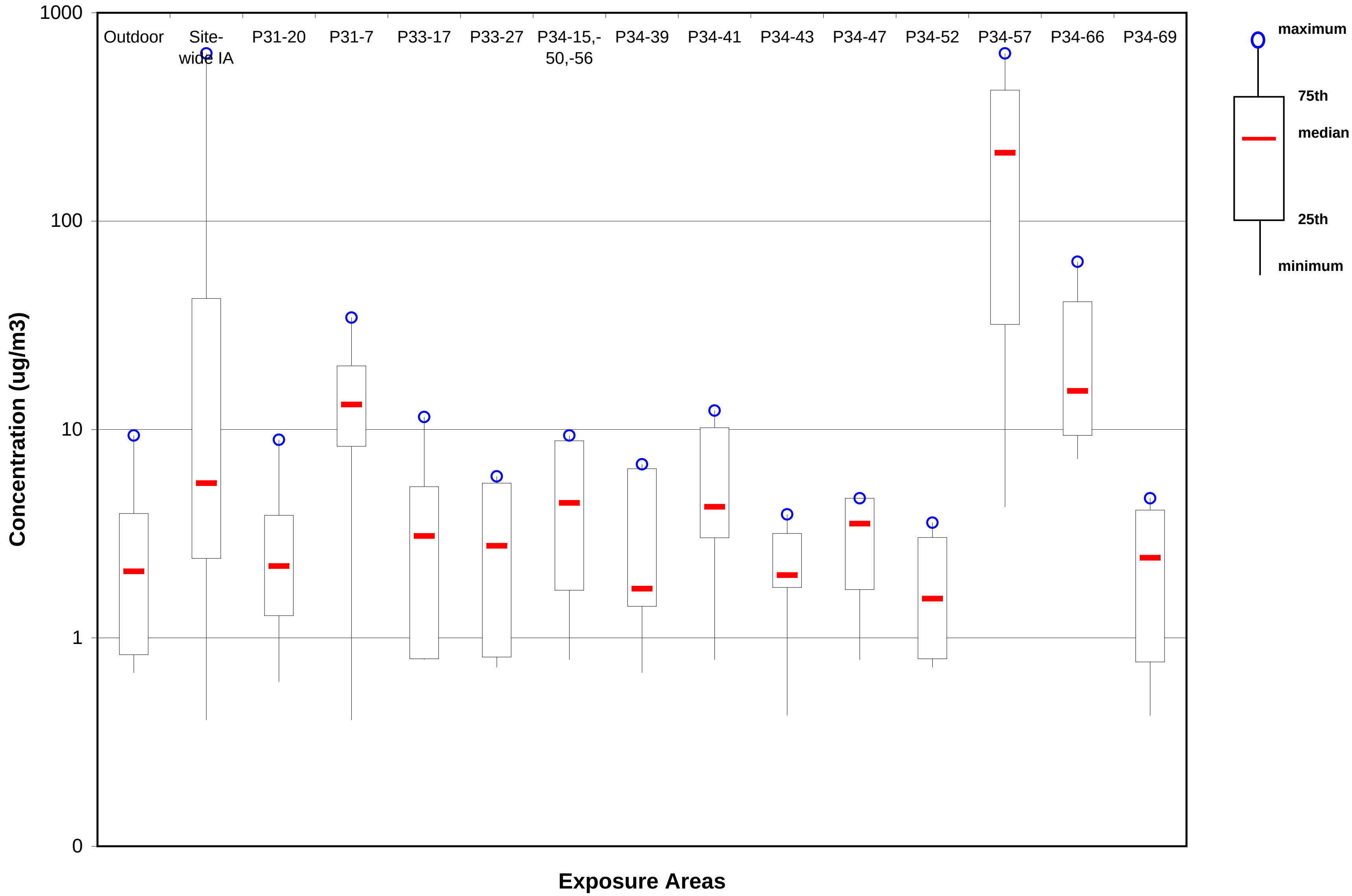


Figure H-26
Tetrachloroethene

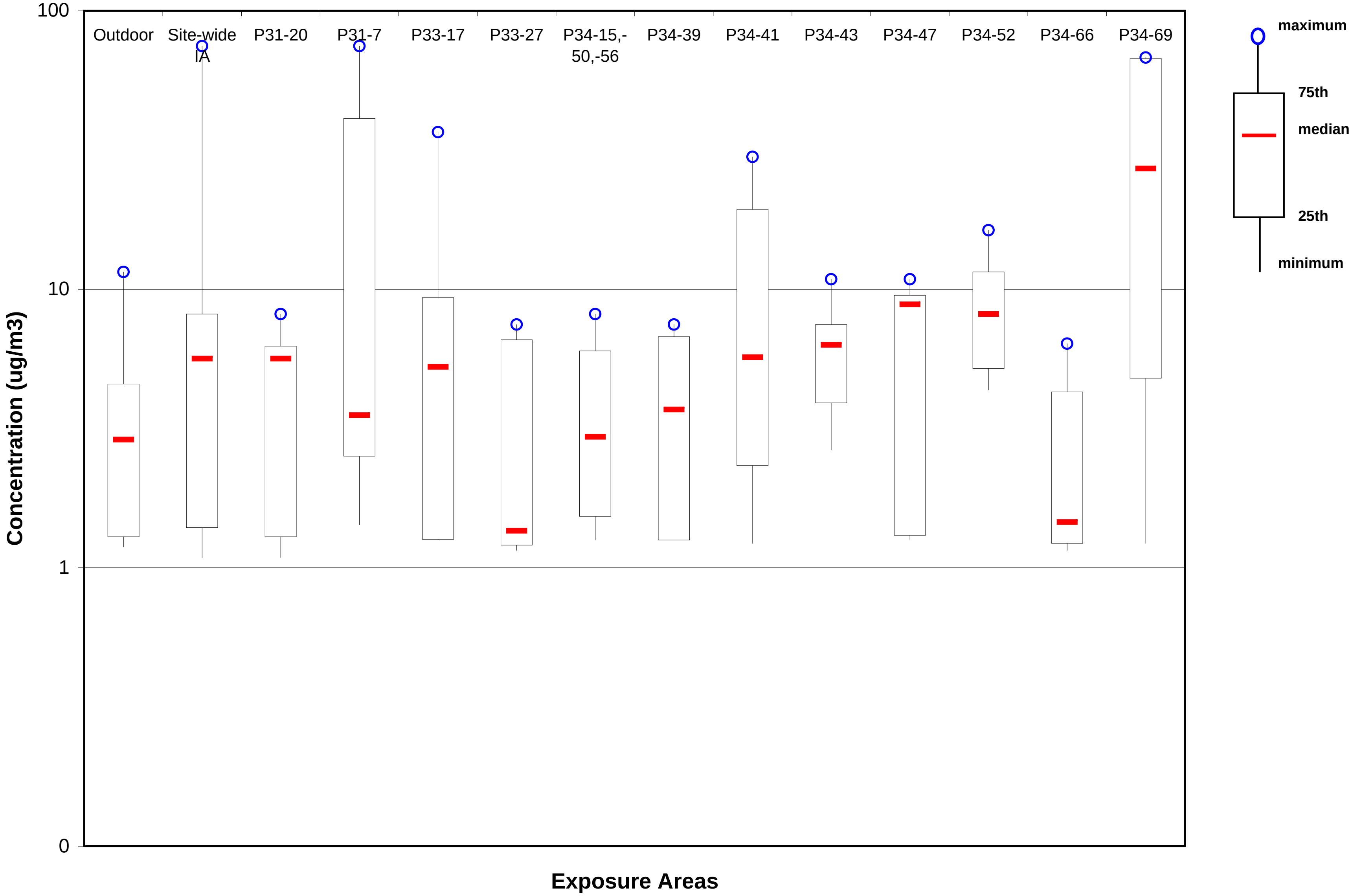


Figure H-27
Toluene

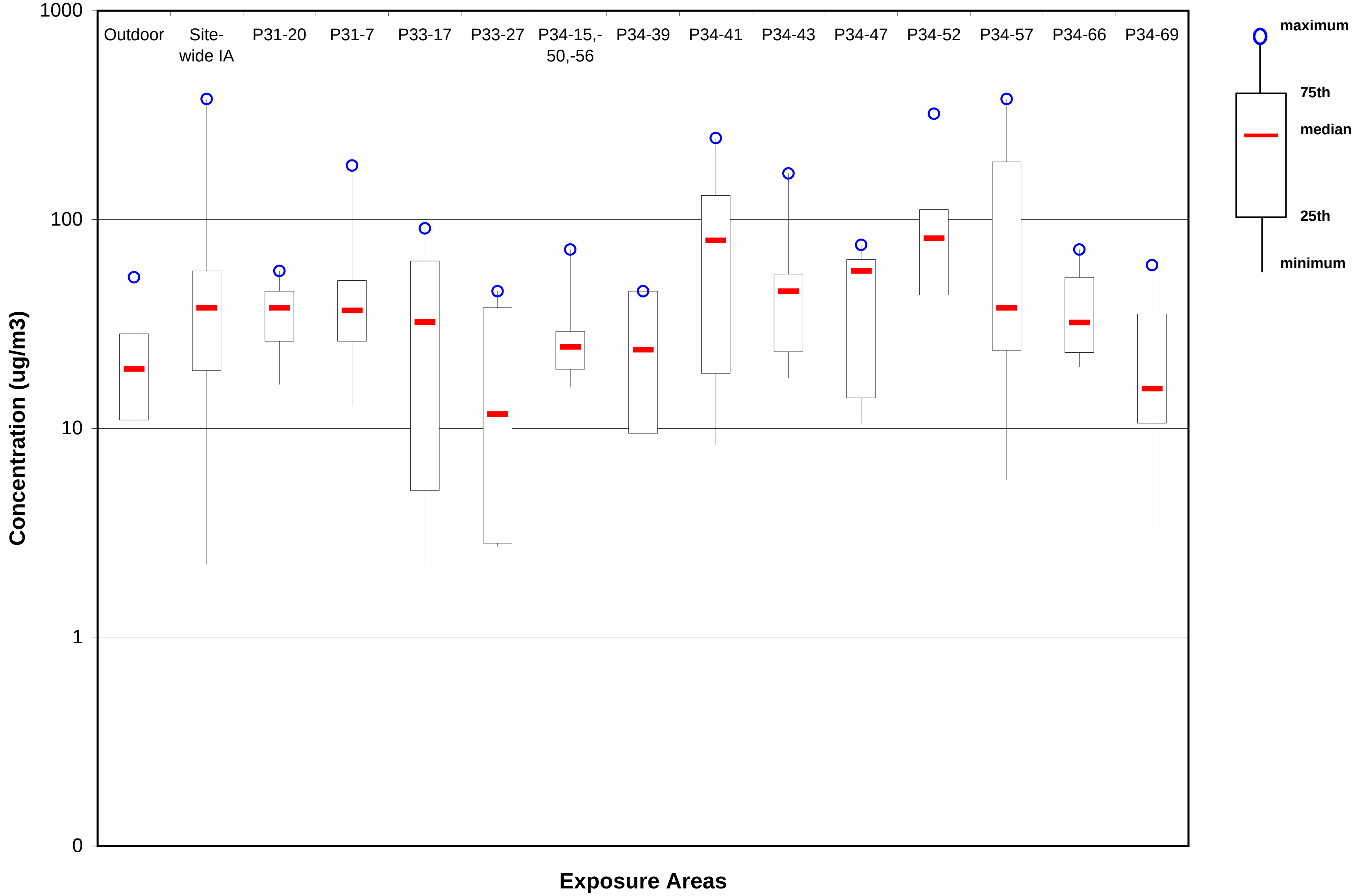


Figure H-28
Trichloroethene

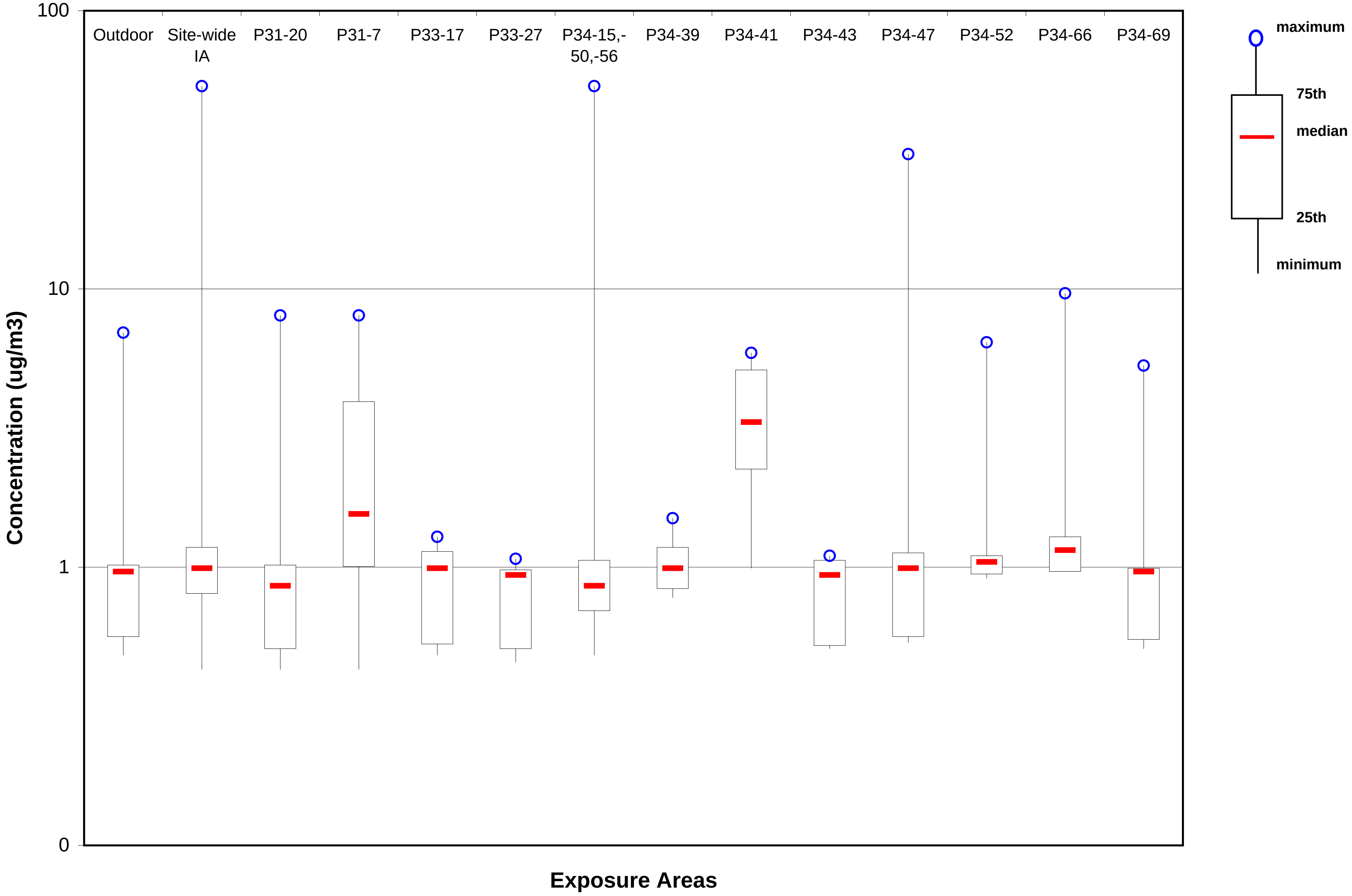


Figure H-29
m,p-Xylene

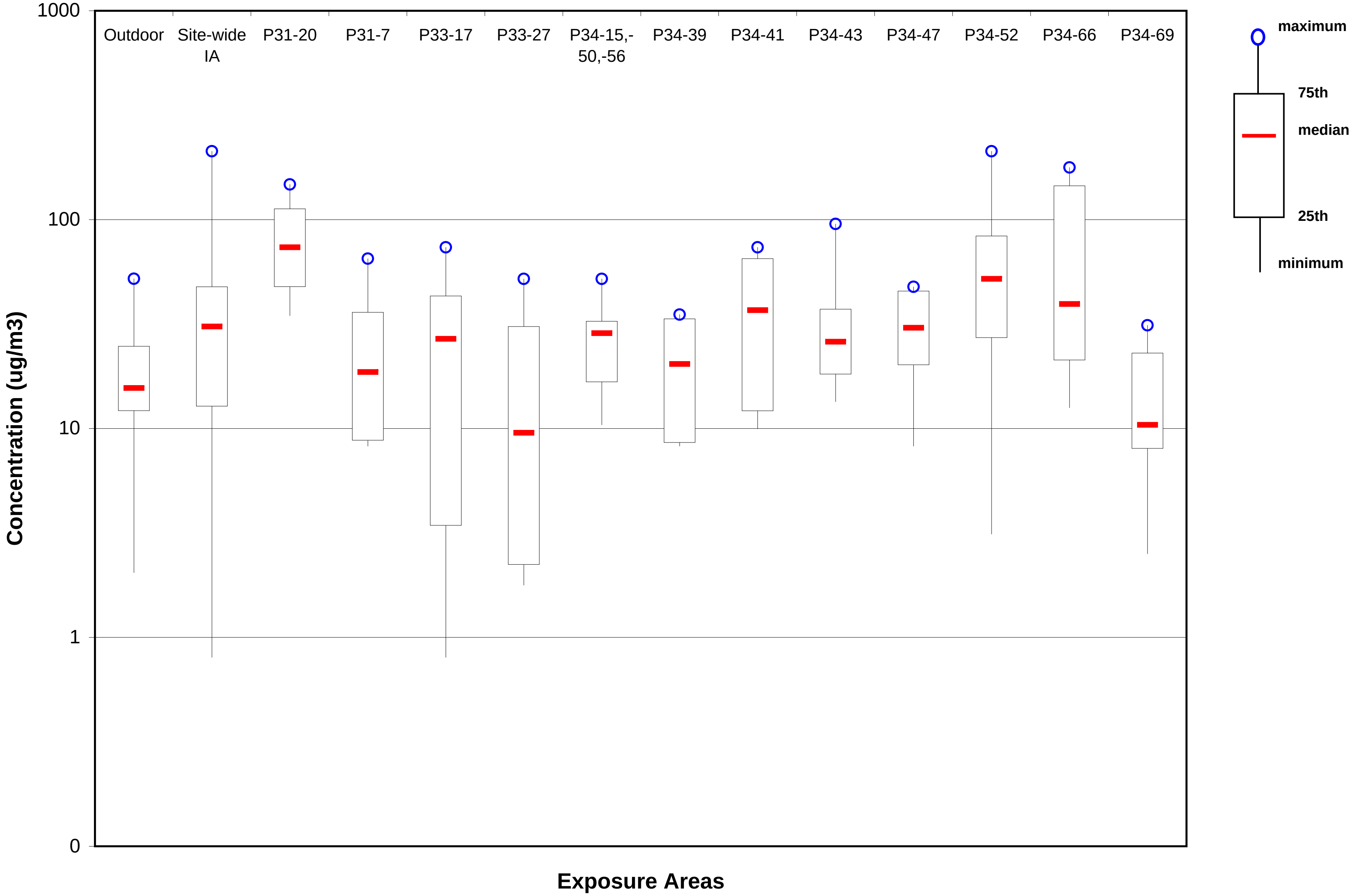


Figure H-30
o-Xylene